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(12) **United States Patent**
Awano

(10) **Patent No.: US 7,360,958 B2**
(45) **Date of Patent: Apr. 22, 2008**

(54) **SHEET PROCESSING APPARATUS**

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(73) Assignee: **Fuji Xerox Co., Ltd.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/681,127**

(22) Filed: **Oct. 9, 2003**

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(30) **Foreign Application Priority Data**

Feb. 27, 2003 (JP) 2003-050438

(51) **Int. Cl.**
B41J 11/00 (2006.01)

(52) **U.S. Cl.** **400/621**; 399/407; 270/58.07; 83/76.8

(58) **Field of Classification Search** 83/73, 83/76, 76.1, 76.6, 76.7, 76.8; 400/621; 270/1.03, 270/5.02, 21.1; 271/58.07; 399/407
See application file for complete search history.

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Primary Examiner—Ren Yan
(74) *Attorney, Agent, or Firm*—Morgan, Lewis & Bockius LLP

(57) **ABSTRACT**

There are provided a sheet inlet, a saddle-stitch compilation tray for aligning and accommodating plural sheets that are input through the sheet inlet, and a rotary cutter unit for cutting a saddle-stitched sheaf of sheets accommodated in the saddle-stitch compilation tray. In the rotary cutter unit, a sheaf of sheets is cut by moving a circular blade in a direction perpendicular to a sheet transport direction of a sheet transport path from one end in the direction perpendicular to the sheet transport direction. Different sheaves of sheets may be cut by a go-movement and a return-movement of the circular blade.

6 Claims, 18 Drawing Sheets

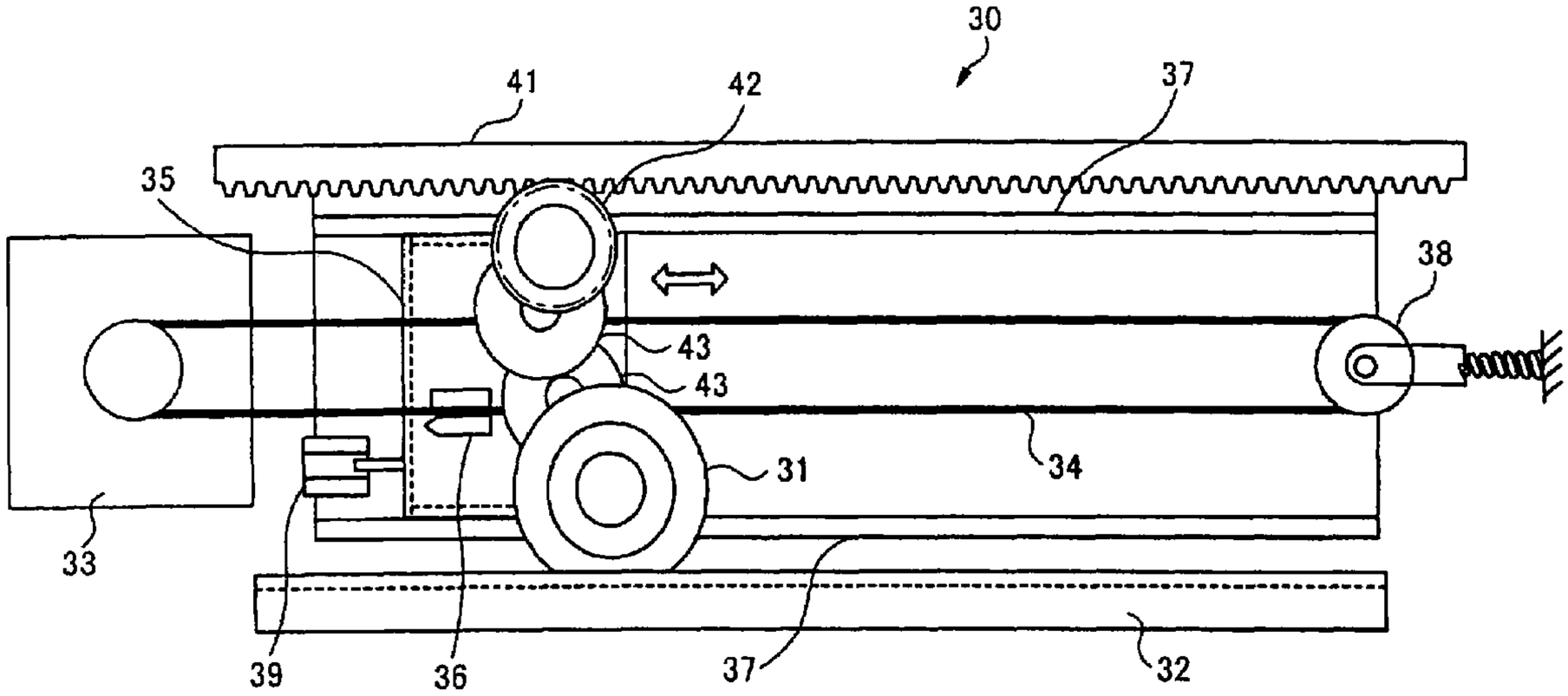
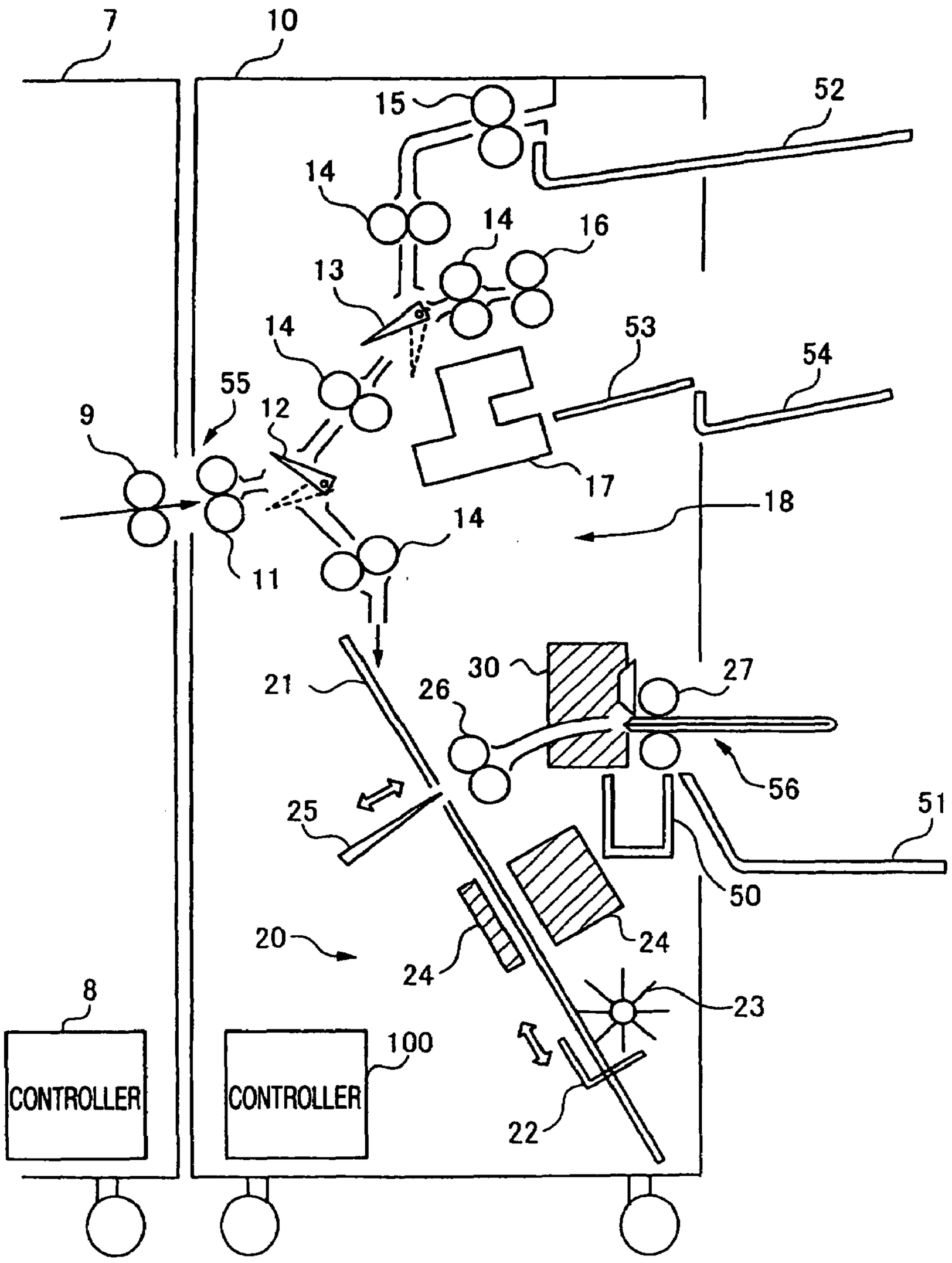


FIG. 1


7
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14
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21
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56
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51
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20
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24
23
8
100
22
CONTROLLER
CONTROLLER

FIG. 2

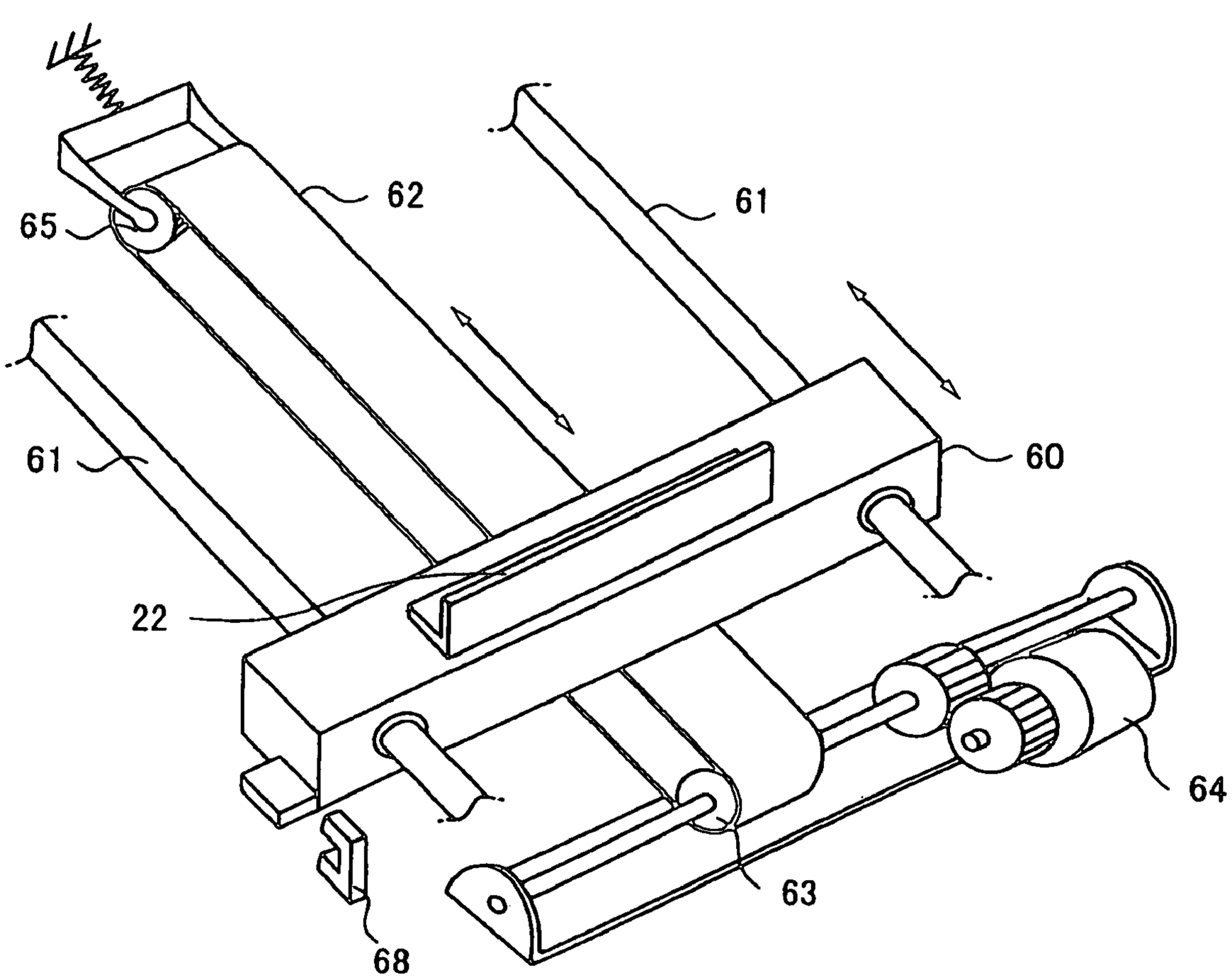


FIG. 3A

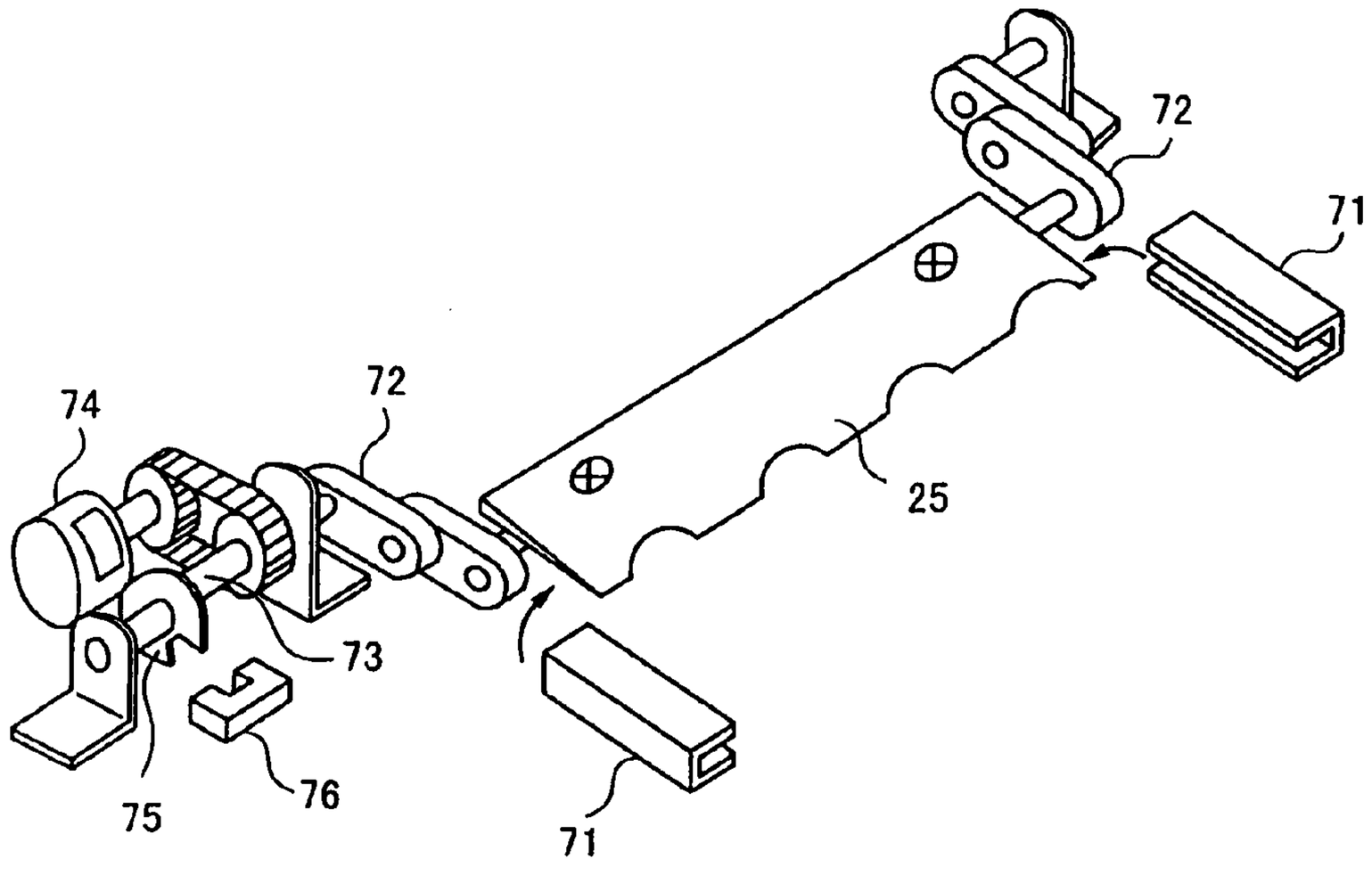


FIG. 3B

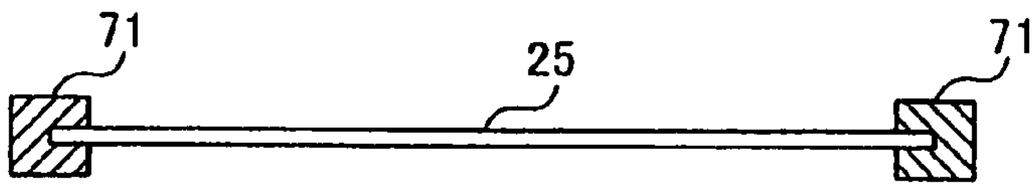


FIG. 4A

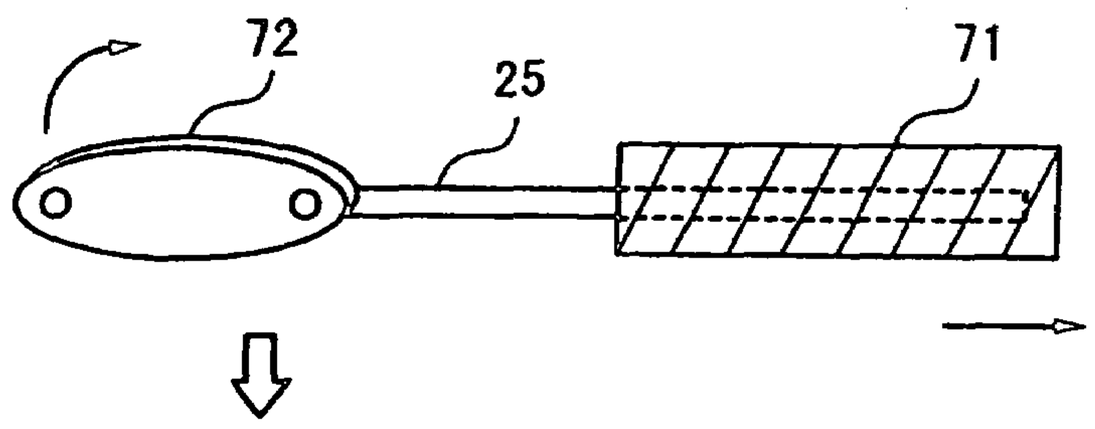


FIG. 4B

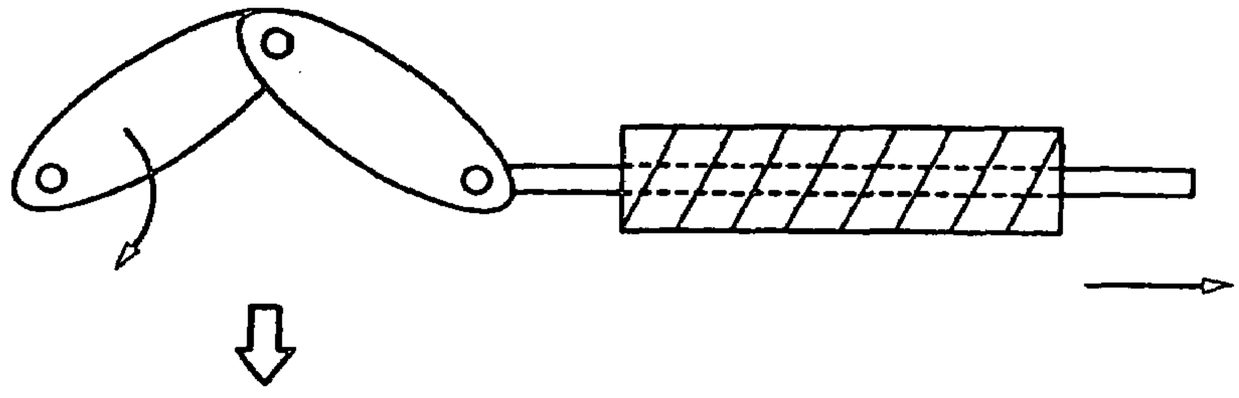


FIG. 4C

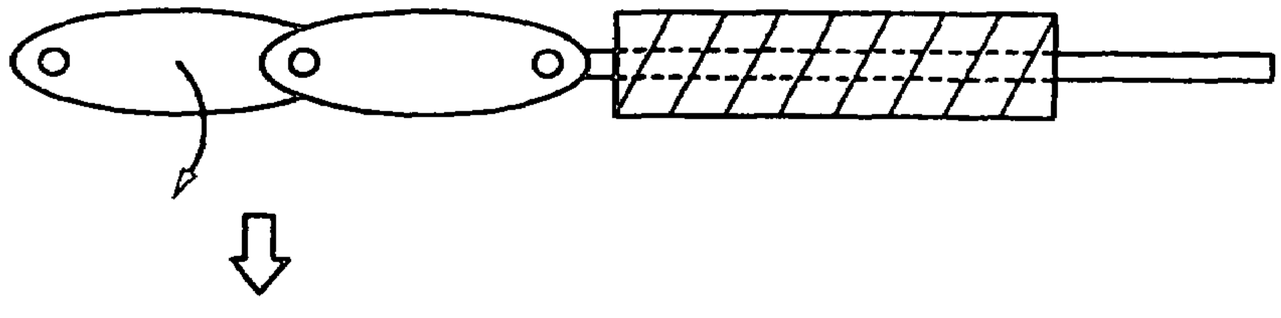


FIG. 4D

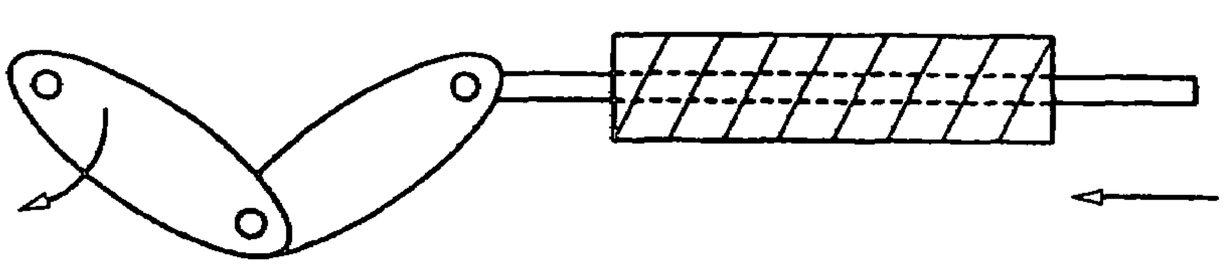
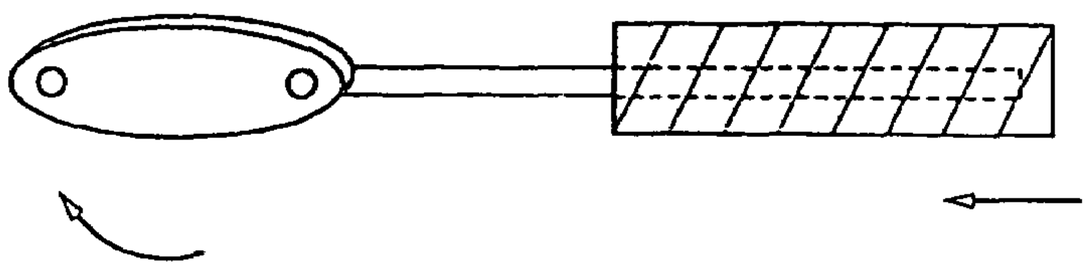


FIG. 4E



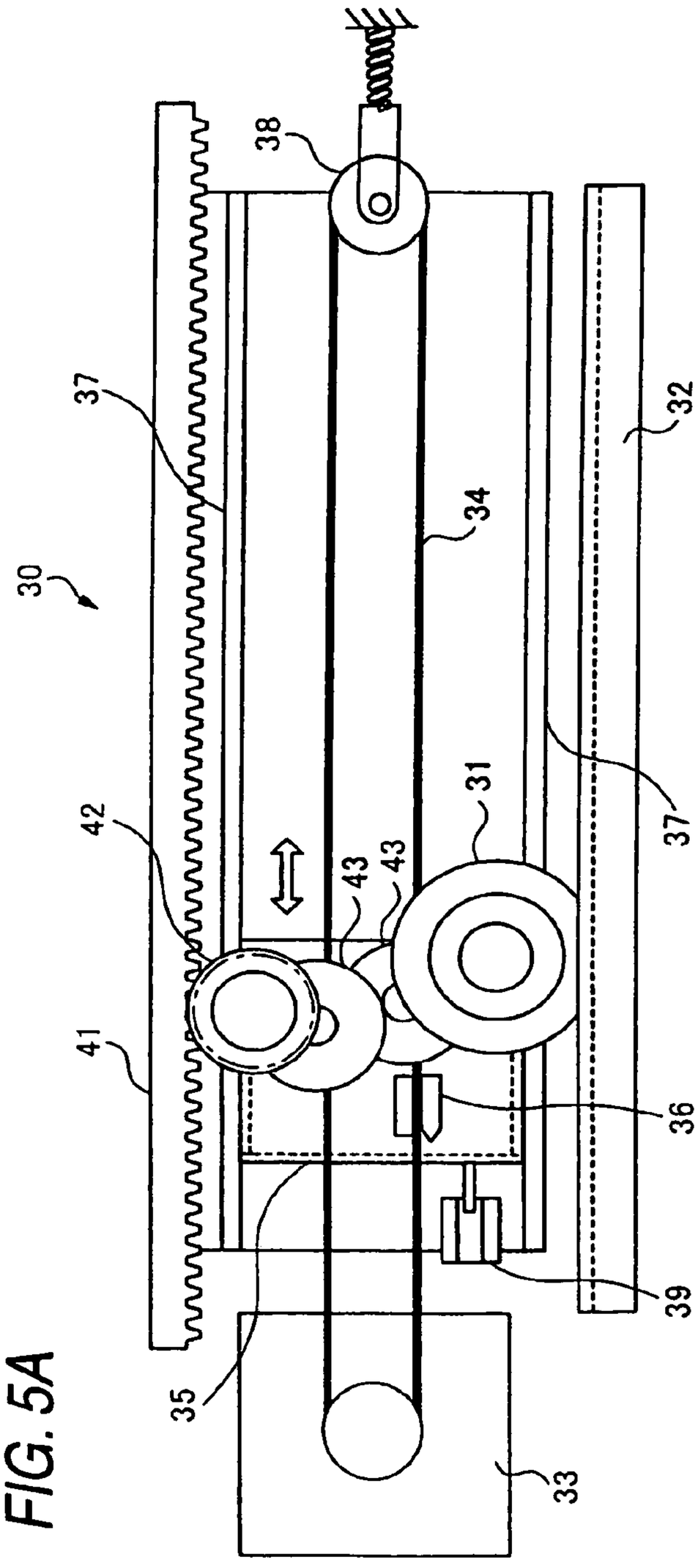


FIG. 5A

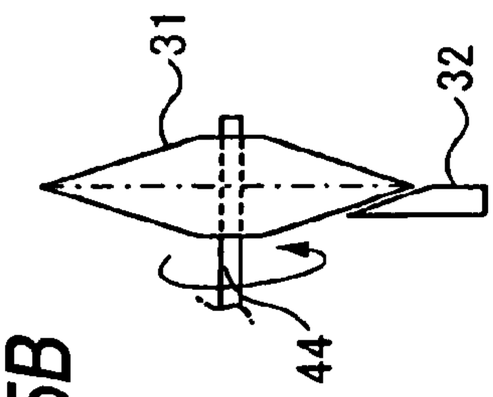


FIG. 5B

FIG. 6A

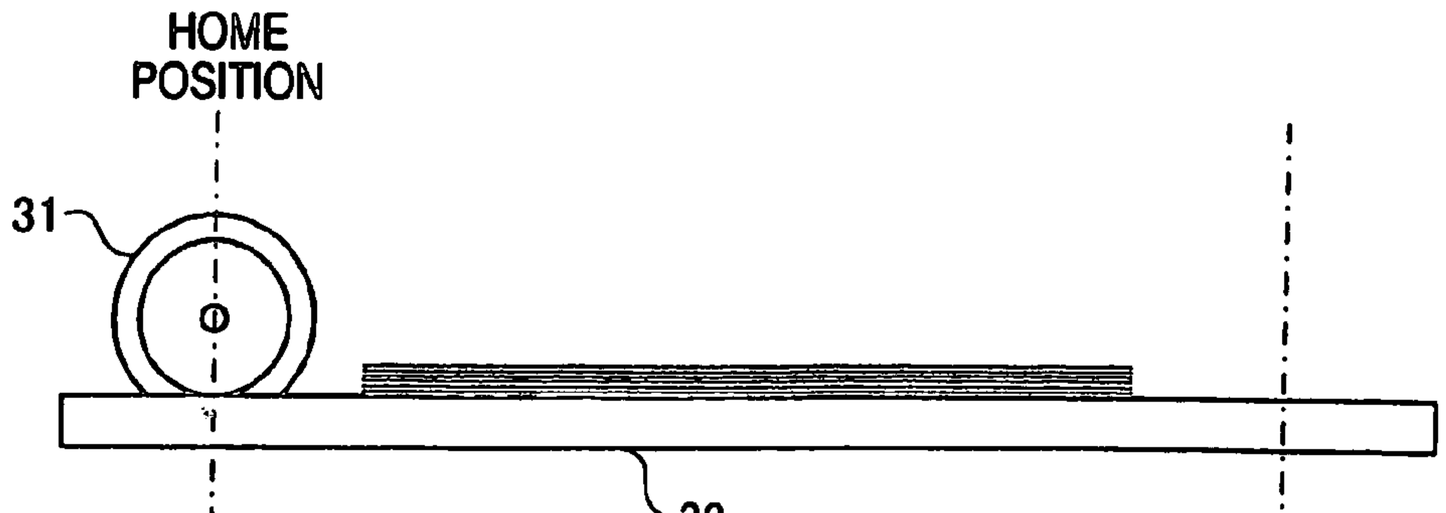


FIG. 6B

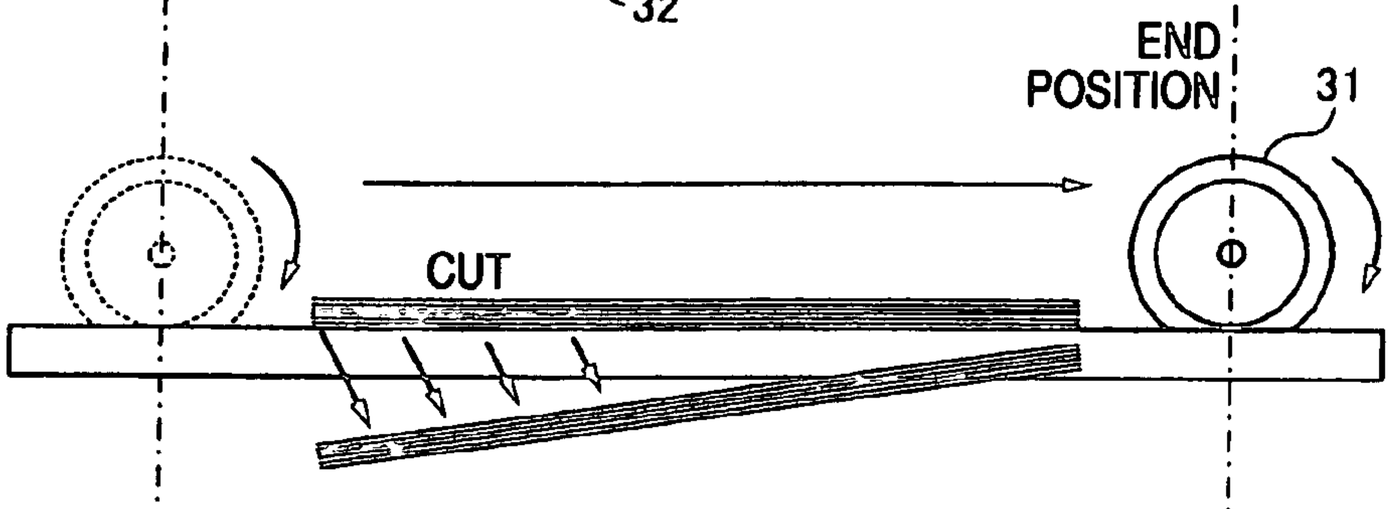


FIG. 6C

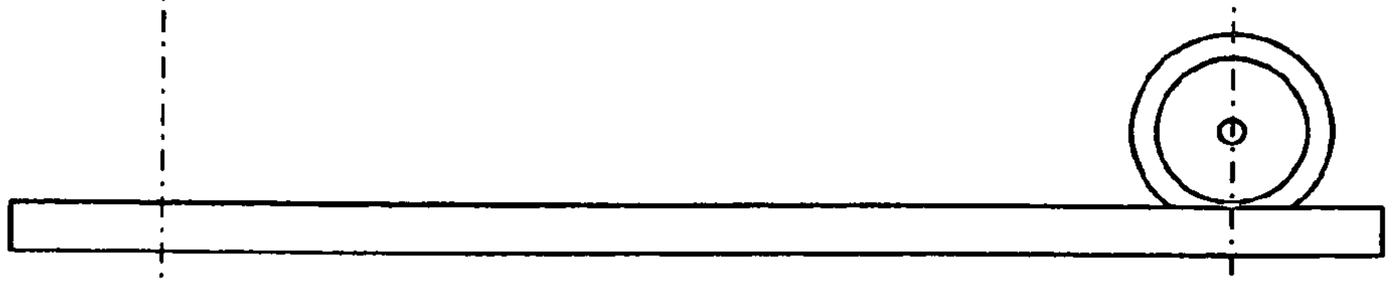


FIG. 6D

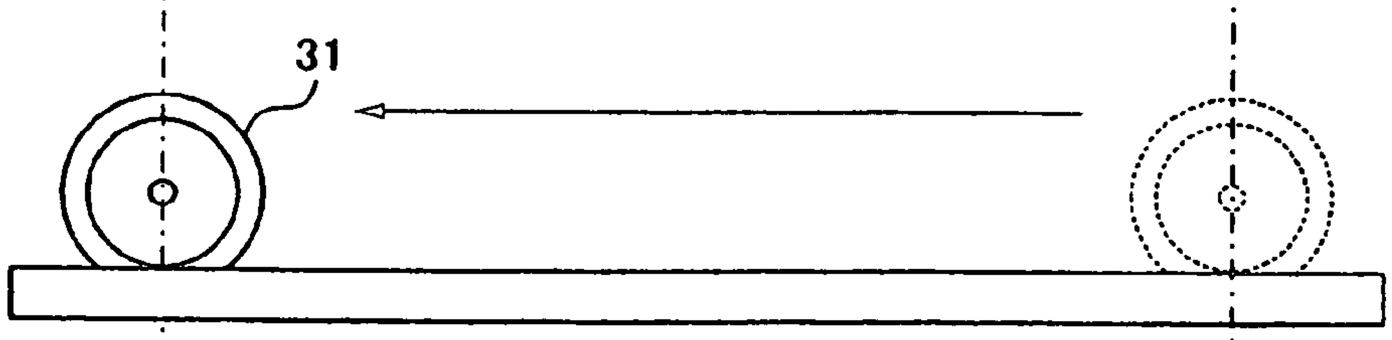


FIG. 6E

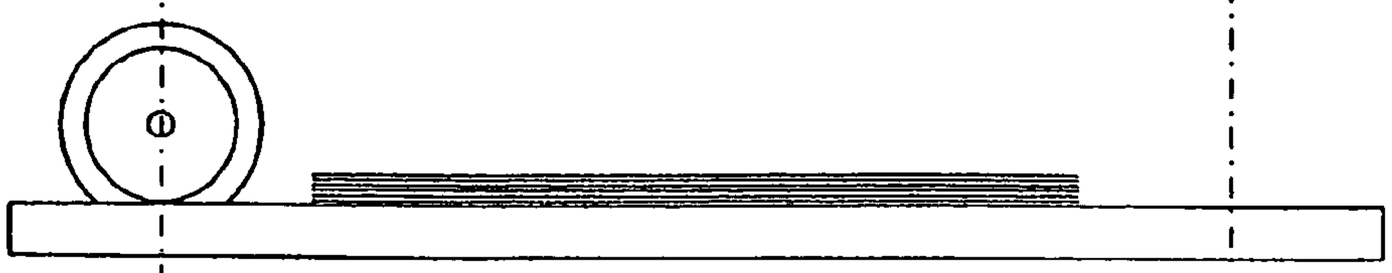


FIG. 7A

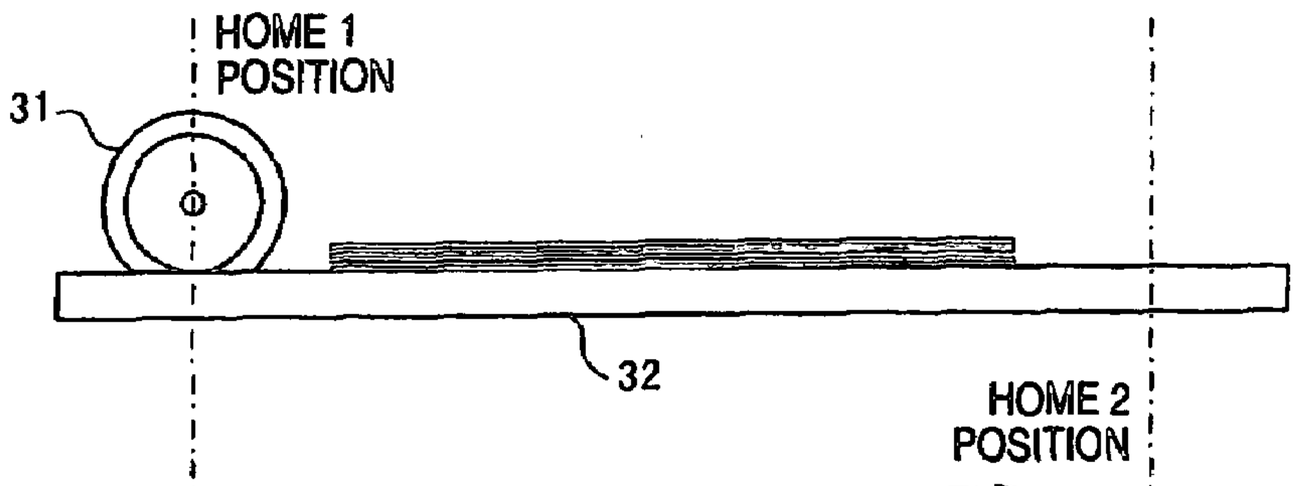


FIG. 7B

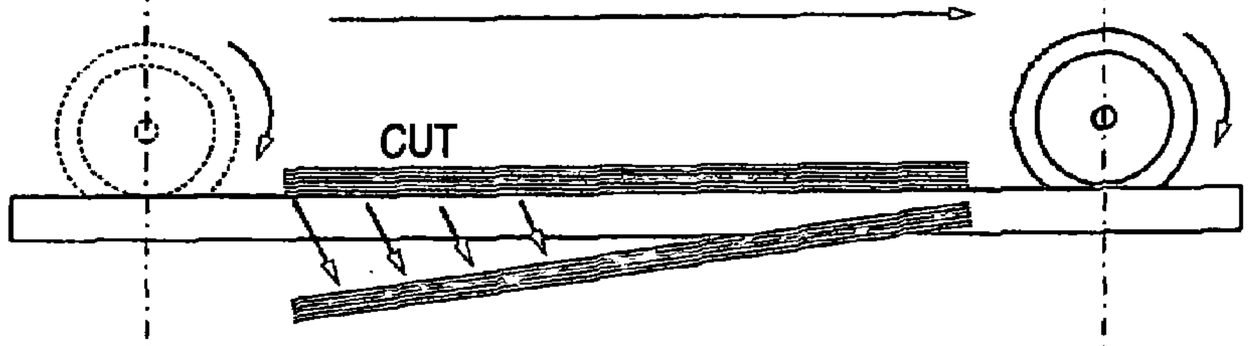


FIG. 7C

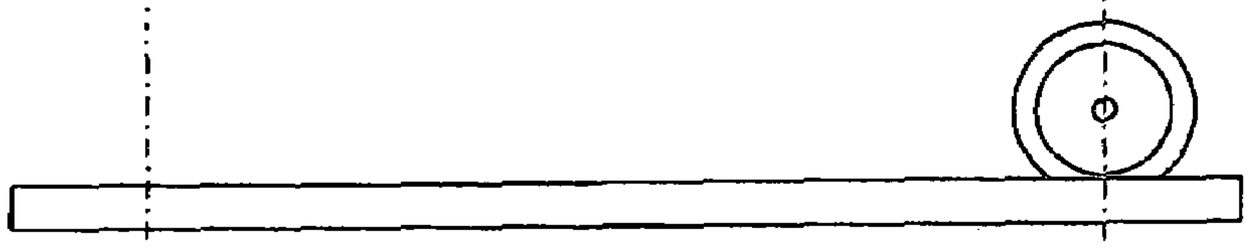


FIG. 7D

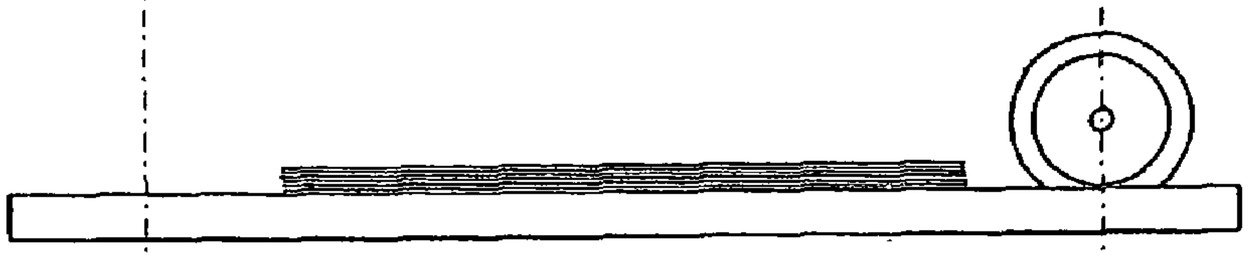


FIG. 7E

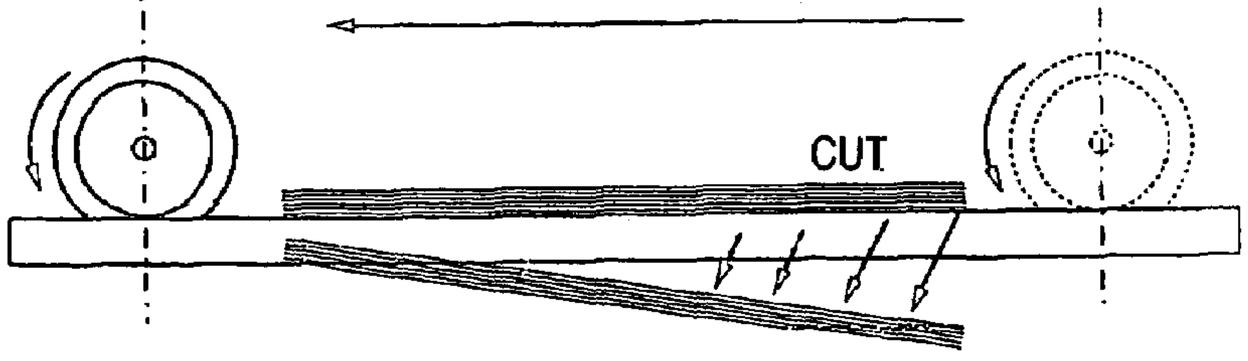


FIG. 8A

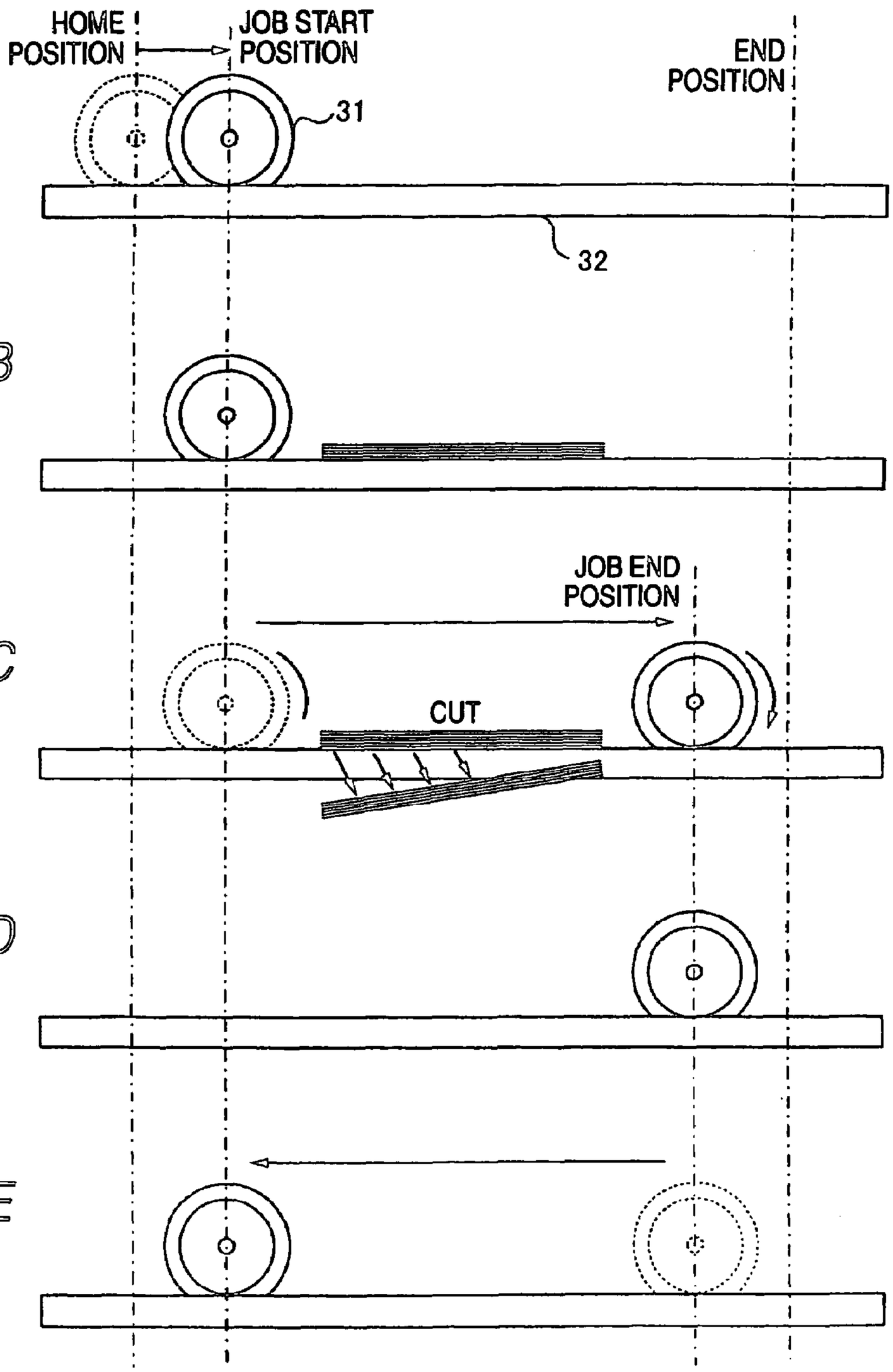


FIG. 8B

FIG. 8C

FIG. 8D

FIG. 8E

FIG. 9A

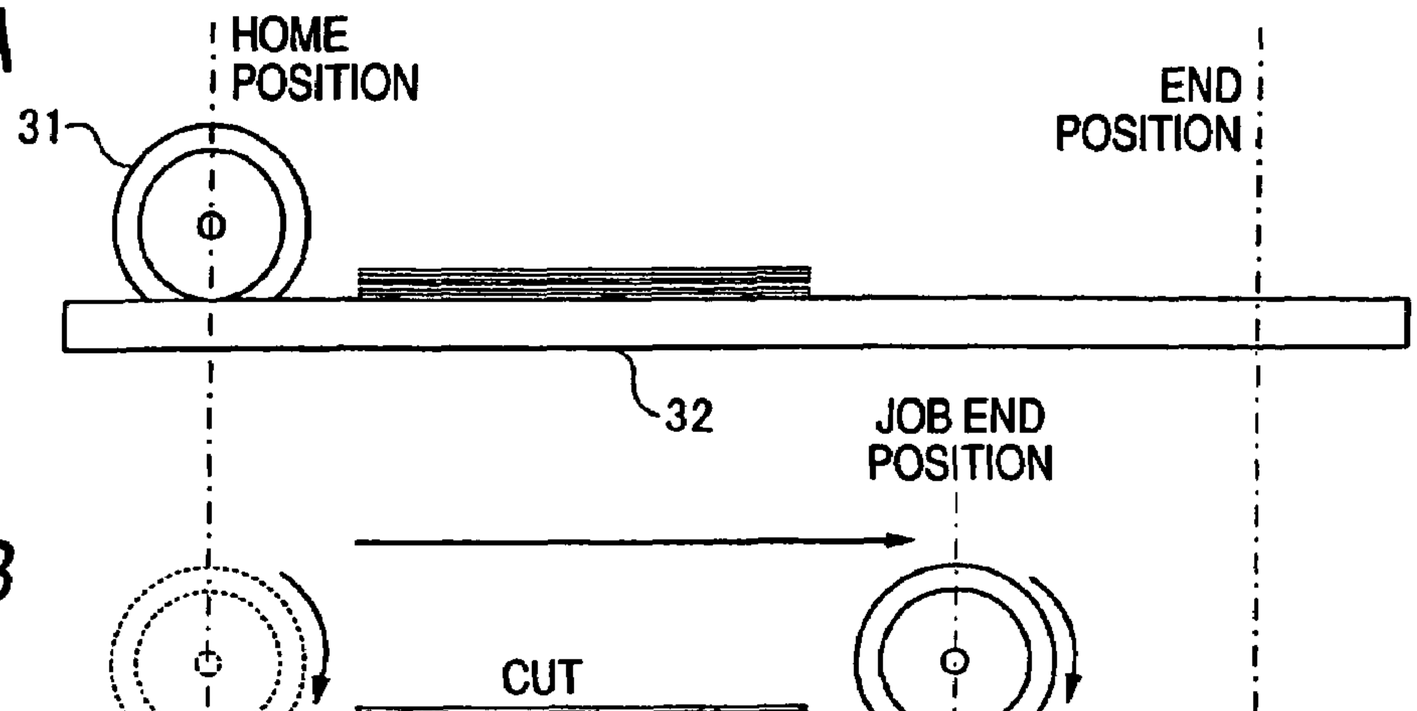


FIG. 9B

FIG. 9C

FIG. 9D

FIG. 10A

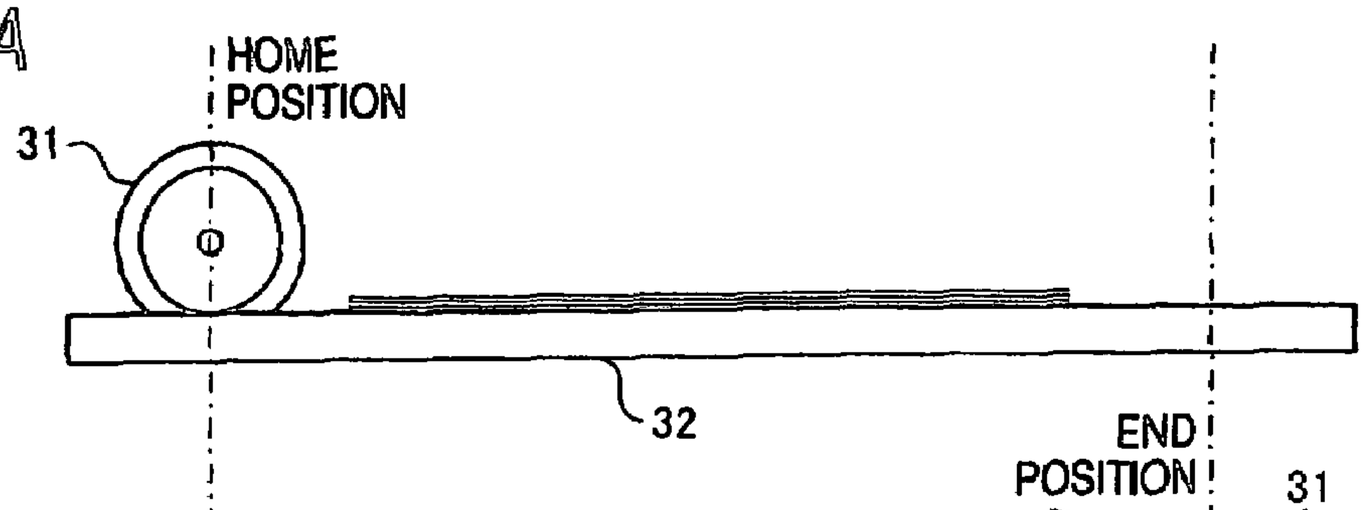


FIG. 10B

FIG. 10C

FIG. 10D

FIG. 10E

FIG. 11A

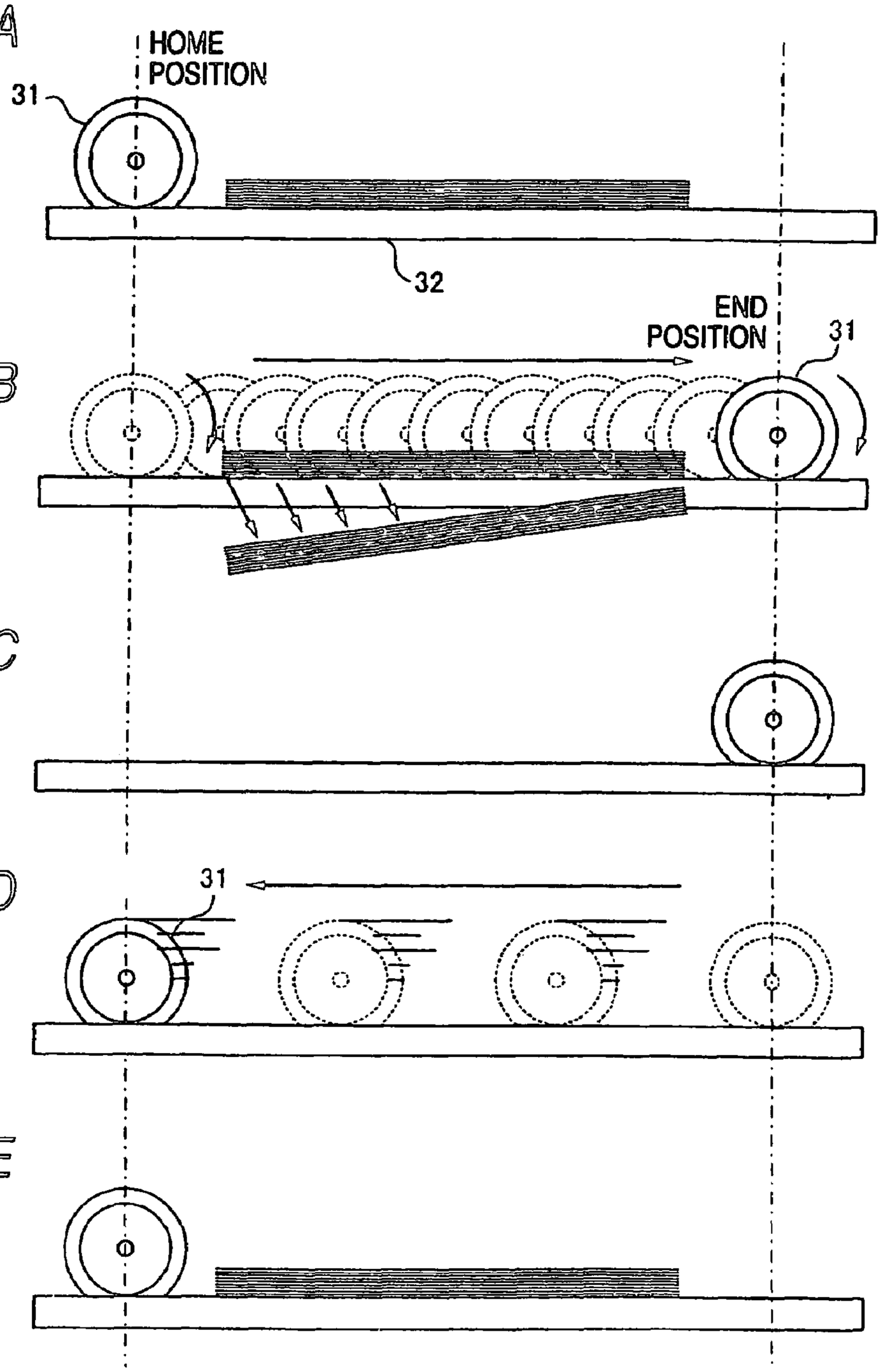


FIG. 11B

FIG. 11C

FIG. 11D

FIG. 11E

FIG. 12

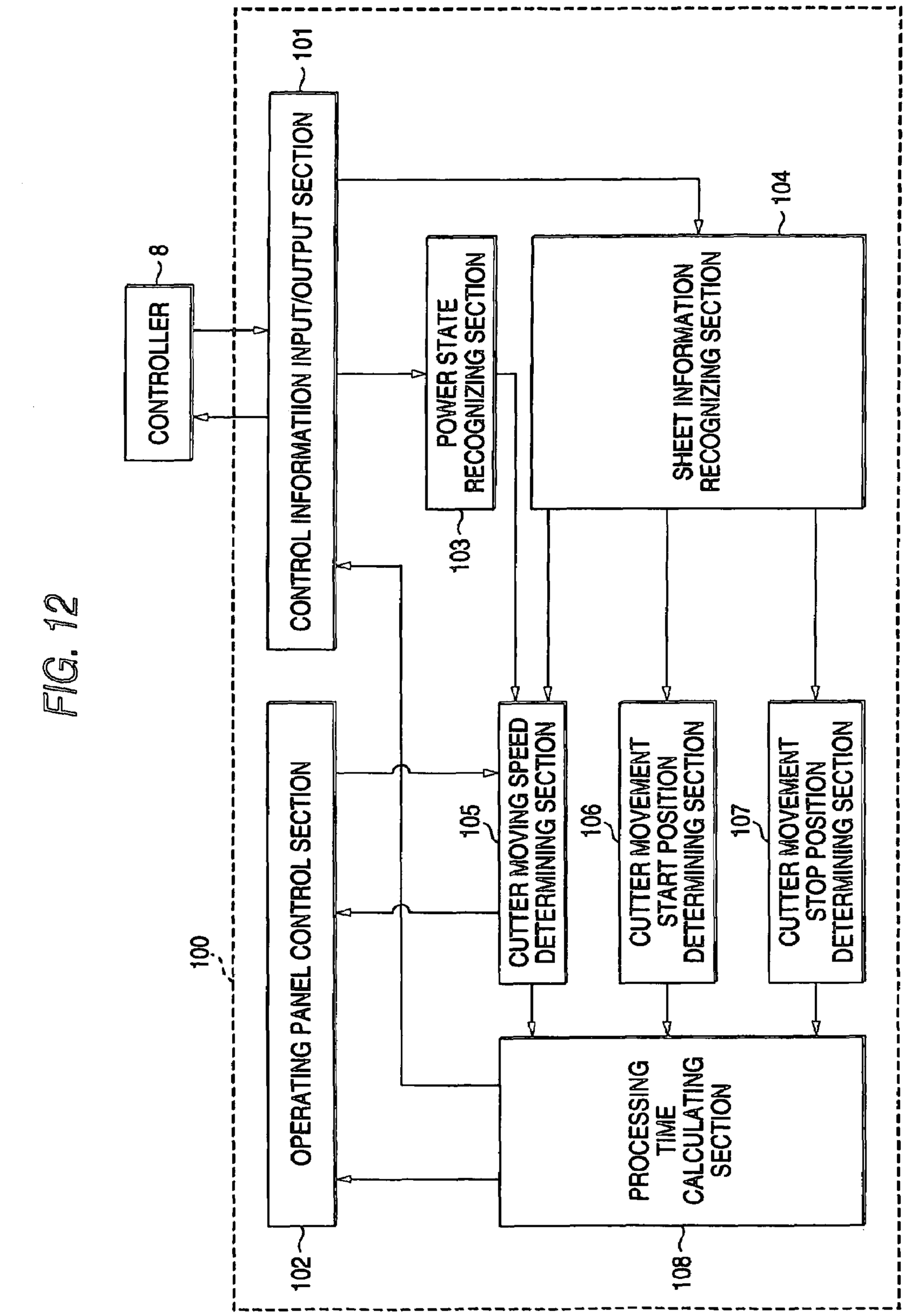

100
101
CONTROL INFORMATION INPUT/OUTPUT SECTION
8
CONTROLLER
102
OPERATING PANEL CONTROL SECTION
103
POWER STATE RECOGNIZING SECTION
104
SHEET INFORMATION RECOGNIZING SECTION
105
CUTTER MOVING SPEED DETERMINING SECTION
106
CUTTER MOVEMENT START POSITION DETERMINING SECTION
107
CUTTER MOVEMENT STOP POSITION DETERMINING SECTION
108
PROCESSING TIME CALCULATING SECTION

FIG. 13

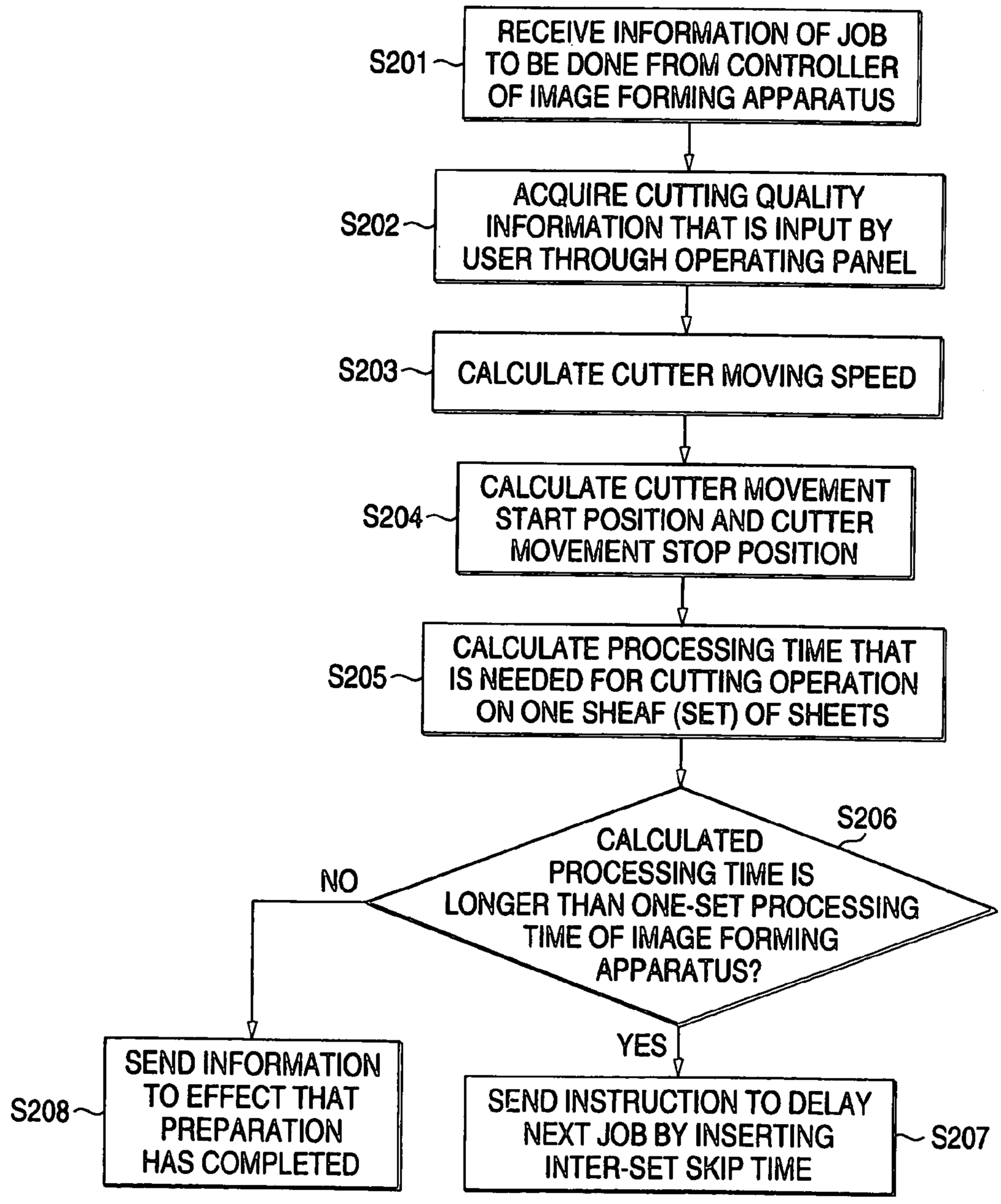

S201
RECEIVE INFORMATION OF JOB TO BE DONE FROM CONTROLLER OF IMAGE FORMING APPARATUS
S202
ACQUIRE CUTTING QUALITY INFORMATION THAT IS INPUT BY USER THROUGH OPERATING PANEL
S203
CALCULATE CUTTER MOVING SPEED
S204
CALCULATE CUTTER MOVEMENT START POSITION AND CUTTER MOVEMENT STOP POSITION
S205
CALCULATE PROCESSING TIME THAT IS NEEDED FOR CUTTING OPERATION ON ONE SHEAF (SET) OF SHEETS
S206
CALCULATED PROCESSING TIME IS LONGER THAN ONE-SET PROCESSING TIME OF IMAGE FORMING APPARATUS?
NO
YES
S208
SEND INFORMATION TO EFFECT THAT PREPARATION HAS COMPLETED
SEND INSTRUCTION TO DELAY NEXT JOB BY INSERTING INTER-SET SKIP TIME
S207

FIG. 14

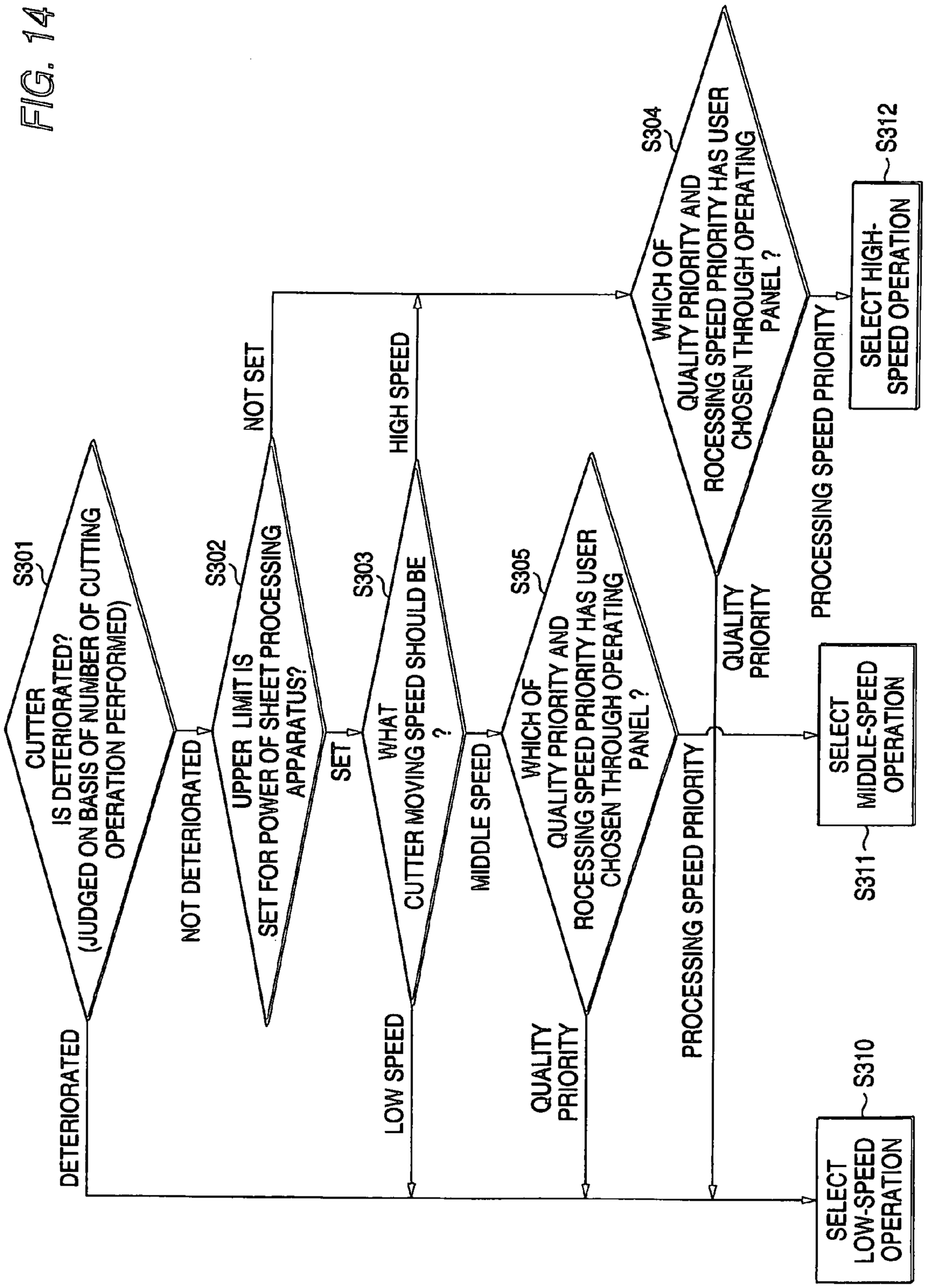

S301
CUTTER IS DETERIORATED? (JUDGED ON BASIS OF NUMBER OF CUTTING OPERATION PERFORMED)
DETERIORATED
NOT DETERIORATED
S302
UPPER LIMIT IS SET FOR POWER OF SHEET PROCESSING APPARATUS?
NOT SET
SET
S303
WHAT CUTTER MOVING SPEED SHOULD BE ?
LOW SPEED
MIDDLE SPEED
HIGH SPEED
S304
WHICH OF QUALITY PRIORITY AND PROCESSING SPEED PRIORITY HAS USER CHOSEN THROUGH OPERATING PANEL ?
S305
WHICH OF QUALITY PRIORITY AND PROCESSING SPEED PRIORITY HAS USER CHOSEN THROUGH OPERATING PANEL ?
QUALITY PRIORITY
PROCESSING SPEED PRIORITY
QUALITY PRIORITY
PROCESSING SPEED PRIORITY
S310
SELECT LOW-SPEED OPERATION
S311
SELECT MIDDLE-SPEED OPERATION
S312
SELECT HIGH-SPEED OPERATION

FIG. 15

NUMBER OF SHEETS	ORDINARY SHEET	THICK SHEET-1	THICK SHEET-2
2	HIGH SPEED (- 512gsm)	HIGH SPEED (- 648gsm)	HIGH SPEED (- 880gsm)
3	HIGH SPEED (- 768gsm)	HIGH SPEED (- 972gsm)	MIDDLE SPEED (- 1320gsm)
4	HIGH SPEED (- 1024gsm)	MIDDLE SPEED (- 1296gsm)	MIDDLE SPEED (- 1760gsm)
5	HIGH SPEED (- 1280gsm)	MIDDLE SPEED (- 1620gsm)	MIDDLE SPEED (- 2200gsm)
6	MIDDLE SPEED (- 1536gsm)	MIDDLE SPEED (- 1944gsm)	LOW SPEED (- 2640gsm)
7	MIDDLE SPEED (- 1792gsm)	MIDDLE SPEED (- 2268gsm)	LOW SPEED (- 3080gsm)
8	MIDDLE SPEED (- 2048gsm)	LOW SPEED (- 2592gsm)	LOW SPEED (- 3520gsm)
9	MIDDLE SPEED (- 2304gsm)	LOW SPEED (- 2916gsm)	BOOK FORMATION IMPOSSIBLE
10	MIDDLE SPEED (- 2560gsm)	LOW SPEED (- 3240gsm)	BOOK FORMATION IMPOSSIBLE
11	LOW SPEED (- 2816gsm)	LOW SPEED (- 3564gsm)	BOOK FORMATION IMPOSSIBLE
12	LOW SPEED (- 3072gsm)	BOOK FORMATION IMPOSSIBLE	BOOK FORMATION IMPOSSIBLE
13	LOW SPEED (- 3328gsm)	BOOK FORMATION IMPOSSIBLE	BOOK FORMATION IMPOSSIBLE
14	LOW SPEED (- 3584gsm)	BOOK FORMATION IMPOSSIBLE	BOOK FORMATION IMPOSSIBLE
15	LOW SPEED (- 3840gsm)	BOOK FORMATION IMPOSSIBLE	BOOK FORMATION IMPOSSIBLE

FIG. 16

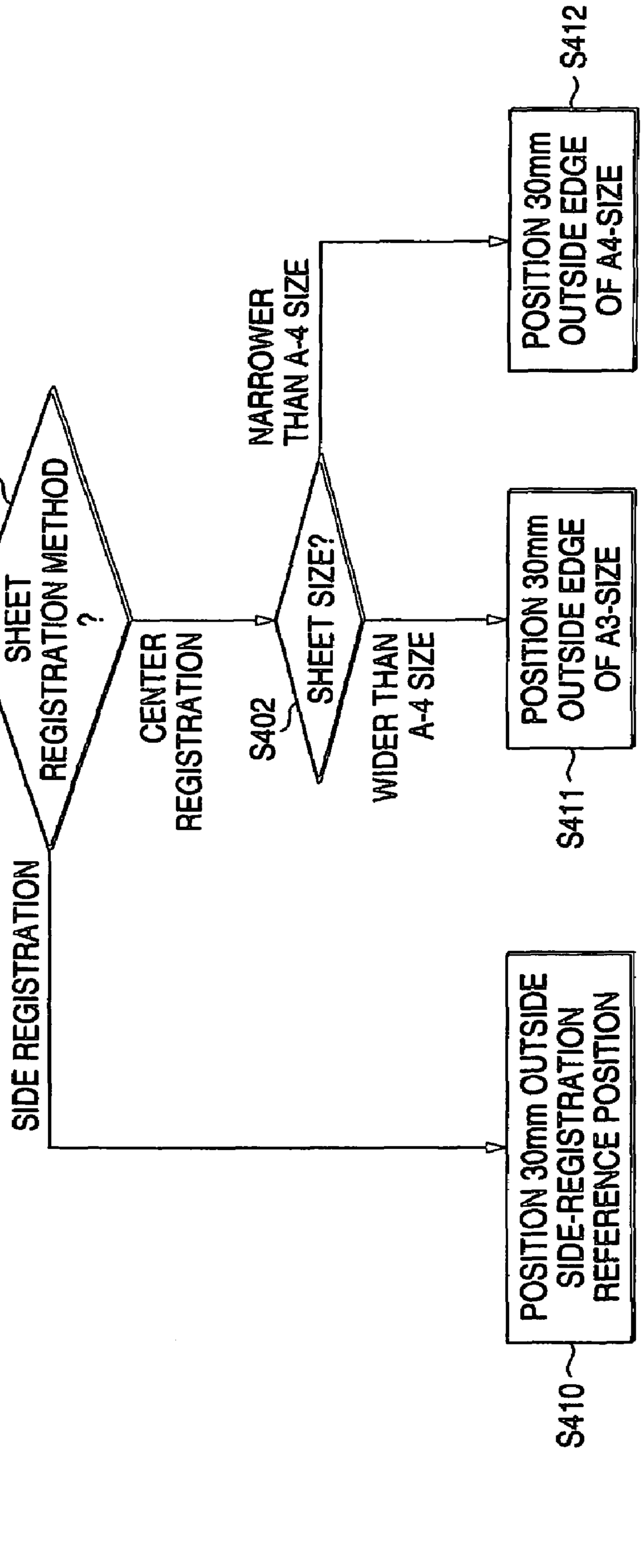

S401
SHEET REGISTRATION METHOD ?
SIDE REGISTRATION
CENTER REGISTRATION
S402
SHEET SIZE?
NARROWER THAN A-4 SIZE
WIDER THAN A-4 SIZE
S410
POSITION 30mm OUTSIDE SIDE-REGISTRATION REFERENCE POSITION
S411
POSITION 30mm OUTSIDE EDGE OF A3-SIZE
S412
POSITION 30mm OUTSIDE EDGE OF A4-SIZE

FIG. 17

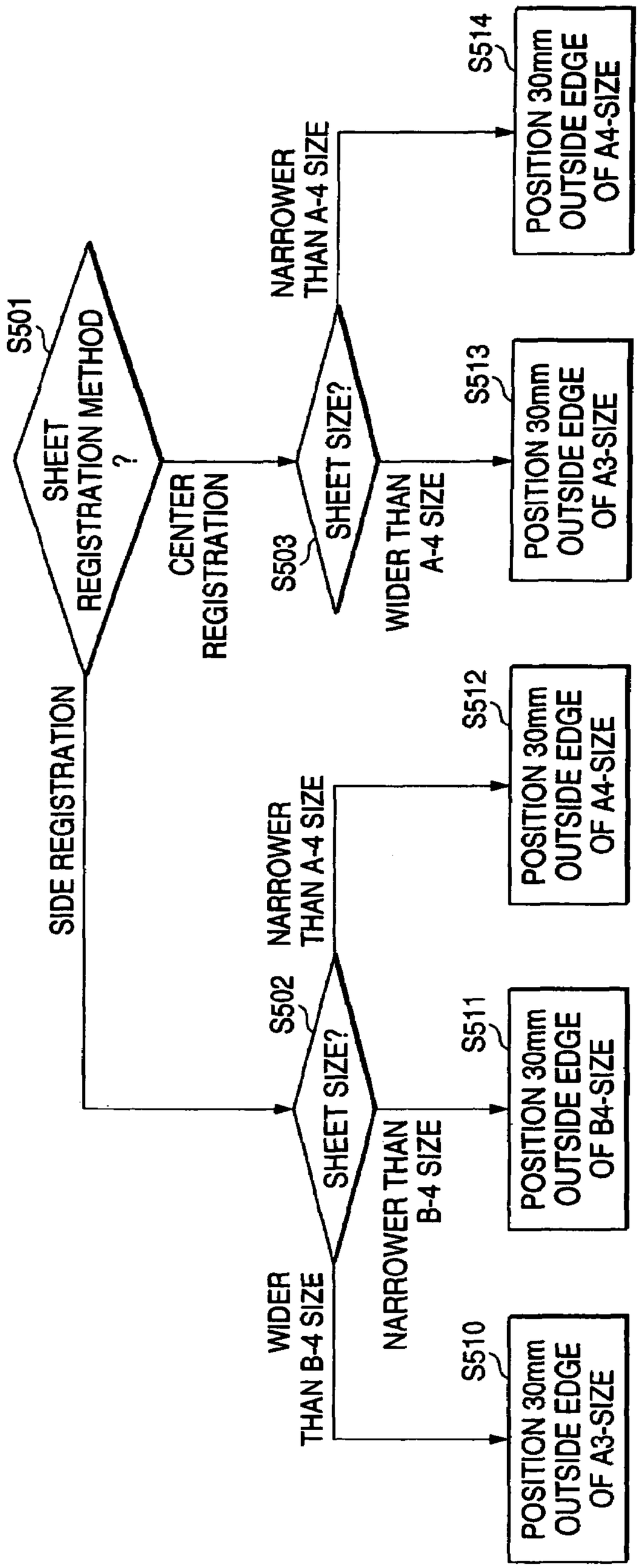
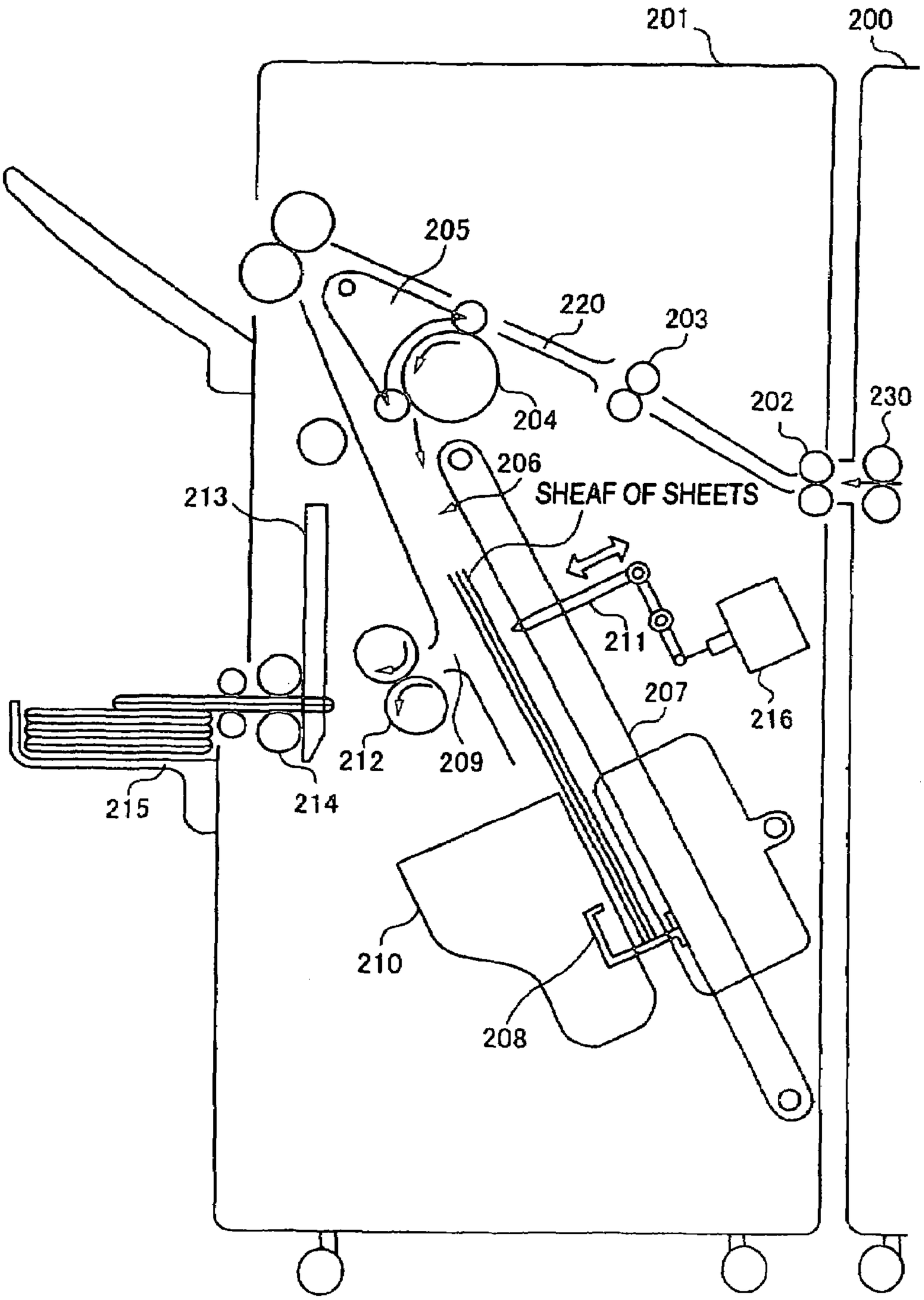

S501
SHEET REGISTRATION METHOD ?
SIDE REGISTRATION
CENTER REGISTRATION
S502
SHEET SIZE?
NARROWER THAN A-4 SIZE
WIDER THAN A-4 SIZE
S503
SHEET SIZE?
NARROWER THAN B-4 SIZE
WIDER THAN B-4 SIZE
S510
POSITION 30mm OUTSIDE EDGE OF A3-SIZE
S511
POSITION 30mm OUTSIDE EDGE OF B4-SIZE
S512
POSITION 30mm OUTSIDE EDGE OF A4-SIZE
S513
POSITION 30mm OUTSIDE EDGE OF A3-SIZE
S514
POSITION 30mm OUTSIDE EDGE OF A4-SIZE

FIG. 18


201
200
205
220
203
204
202
230
206
SHEAF OF SHEETS
213
211
207
216
212
209
215
214
210
208

SHEET PROCESSING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a sheet processing apparatus for processing sheets that are ejected from an image forming apparatus such as a printer or a copier. More specifically, the invention relates to a sheet processing apparatus having a sheet cutting mechanism.

2. Description of the Related Art

A number of proposals have been made conventionally about post-processing apparatus for binding a book using recorded sheets that are ejected from an image forming apparatus such as a printer or a copier and outputting the resulting book. Among those is a sheet post-processing apparatus that staples, on the center line, sheets that have been ejected from an image forming apparatus and are stacked, folds the sheets in half along the stapling line (saddle stitch), presses the folded sheets and cuts of their end portions, and outputs a resulting book.

FIG. **18** illustrates a conventional sheet post-processing apparatus. In the sheet post-processing apparatus **201** that is connected to an image forming apparatus **200**, a sheet that is ejected from sheet ejection rollers **230** of the image forming apparatus **200** is accepted by inlet rollers **202** and then transported along a transport path **220** by transport rollers **203**. The sheet is then moved through a U-turn transport path in which the transport path is extremely bend by using a turn roller **204** and a switching nail **205**, and put into a stacker **206**. A sheaf of sheets is thus stacked in the stacker **206**. The stacked sheaf of sheets is positioned in its width direction by a positioning stopper **208** that can be moved up and down by rotation of a belt **207**, and the sheaf of sheets is then stapled on the center line by a stapler **210**. Subsequently, the positioning stopper **108** is moved upward, whereby the center line reaches the position of a folding blade **211**.

A folding operation is as follows. Upon turning-on of a solenoid **216**, the folding blade **211** is moved downward obliquely, whereby the sheaf of sheets is pressed against the sheaf-of-sheets ejection outlet **209** and starts to be folded. The folded sheaf of sheets is nipped between pre-press rollers **212** and further transported downstream. After the fold is made sharper by a press rollers **214**, the sheaf of sheets is transported to a cutting position of a slide cutting device **213** and stopped there. A cutting blade of the slide cutting device **213** is moved downward, whereby end portions of the folded sheets are cut off in a guillotine-like manner with the cutting blade and a fixed blade. Resulting saddle-stitch books are stacked on a sheet ejection tray **215**.

In connection with the above mechanisms, a technique is known in which a cutting portion is positioned in a state that a sheaf of sheets to be cut is nipped between the press rollers **214** and the sheaf of sheets is cut by lowering a sharp cutting blade of the slide cutting device **213**, whereby a resulting saddle-stitch book is given a clear, accurate edge (e.g., refer to JP-A-2000-143081 (pages 5 and 6 and FIG. 1)). Another technique is known in which end portions of stapled and folded sheets are cut off by a sheet cutting unit such as the slide cutting device **213** in a state that the sheets bridge the sheet cutting unit and a sheet stacking unit such as the sheet ejection tray **215**, whereby the installation area of the apparatus can be reduced by a sheet projection length (e.g., refer to JP-A-2000-103567 (pages 3 and 4 and FIG. 1).

Incidentally, in recent years, it has come to be desired that equipment be reduced in size and from the viewpoint of ecology it has come to be desired strongly that equipment be reduced in power consumption. This trend also applies to post-processing apparatus for image processing apparatus. The techniques of the above-mentioned patent documents employ the guillotine-type slide cutting device is used, which is superior in that the cutting operation is quick. However, because of the guillotine-type, a long stroke is needed for the cutting blade, as a result of which the apparatus is voluminous as a whole. Further, the cutting blade should cover the entire sheet width and hence is costly. Further, instantaneous cutting causes a high degree of load concentration, which requires a very large drive current and starting current. This is a problem that should be solved from the viewpoint of ecology. Still further, since the cutting device itself is large, the degree of freedom in determining its position in the apparatus is low; for example, the ejection outlet should be located low in the apparatus. It was difficult to provide sheet processing apparatus that are easy-to-use to users.

In view of the above, inventors developed and proposed a technique in which a cutter unit for cutting a sheaf of sheets by moving a rotating circular blade in a horizontal direction is provided in the main body of a sheet processing apparatus (Japanese Patent Application No. 2002-364918). Employment of this technique makes it possible to provide a sheet processing apparatus that is smaller in size and maximum power than in the case of using the conventional technique. The inventors have thereafter studied diligently and improved the this technique in terms of power consumption and ease of use to users while maintaining the cutting quality. The present application is to propose such technical items that were not described in the previous application.

SUMMARY OF THE INVENTION

The present invention has been made in view of the above circumstances, and provides a sheet processing apparatus having a sheet cutting function and being low in power consumption.

The invention also provides a sheet processing apparatus that is increased in ease of use to users.

The invention further provides a sheet processing apparatus that provides cutting quality and speed that are suitable for a situation of its use.

In terms of configuration, in the invention, a cutter unit for cutting a sheaf of sheets by, for example, moving a circular blade parallel with sheet surfaces while rotating it is provided inside the main body of a sheet processing apparatus. The cutter unit determines circular blade movement conditions on the basis of various kinds of information such as the number and the kind of sheets that constitute a sheaf. That is, according to one aspect of the invention, a sheet processing apparatus for processing sheets on which images have been formed by an image forming apparatus, comprises sheet accepting unit for accepting sheets from the image forming apparatus; cutting unit for cutting the sheets accepted by the sheet accepting unit with a blade that is moved parallel with sheet surfaces; and recognizing unit for recognizing information relating to the sheets to be cut by the cutting unit, wherein the cutting unit determines a condition of cutting of the sheets on the basis of the information relating the sheets that has been recognized by the recognizing unit.

The cutting condition that is determined by the cutting unit may be a movement condition of the blade that is moved parallel with the sheet surfaces. The movement condition may be a moving speed of the blade that is moved parallel

with the sheet surfaces. The movement condition may also be a movement range of the blade that is moved parallel with the sheet surfaces. For example, the movement range may be determined by a movement start position and/or a movement stop position of the blade that is moved parallel with the sheet surfaces.

The recognizing unit may recognize the number and/or a kind of sheets to be cut in the form of a sheaf. The recognizing unit may also recognize a registration method of the sheets on which the images have been formed by the image forming apparatus. Examples of the sheet registration method are what is called center registration and side registration.

According to another aspect of the invention, a sheet processing apparatus comprises sheet accepting unit for accepting sheets that are output from the image forming apparatus; a sheaf-of-sheets forming unit for forming a sheaf of sheets by aligning the plural sheets accepted by the sheet accepting unit; and cutting unit for cutting the sheaf of sheets formed by the sheaf-of-sheets forming unit, wherein the cutting unit cuts the sheaf of sheets under a cutting condition that is determined on the basis of a power state of the sheet processing apparatus and/or the image forming apparatus. The cutting unit may comprise a circular blade that is moved parallel with sheet surfaces while being rotated and a fixed blade that is opposed to the circular blade and has a blade edge extending parallel with the sheet surfaces, and the cutting unit may determine a movement condition of the circular blade on the basis of the power state. The cutting unit may set a cutting speed lower when a sufficient amount of power is not available than when a sufficient amount of power is available.

According to another aspect of the invention, a sheet processing apparatus comprises recognizing unit for recognizing a request from a user that relates to cutting quality of the cutting unit, such as an instruction that is input by the user through an operating panel, wherein the cutting unit sets a low operation speed for cutting when the recognizing unit recognizes occurrence of a quality priority request.

According to still another aspect of the invention, a sheet processing apparatus comprises cutting unit that reciprocates a blade from a prescribed position in such a manner as to cut the sheaf of sheets by a go-movement and to return the blade to the prescribed position by a return movement, and that waits for input of a next sheaf of sheets in a state that the blade is returned to the prescribed position. The cutting unit sets different moving speeds of the blade for the go-movement and the return movement. The cutting unit may comprise a circular blade that is moved parallel with sheet surfaces while being rotated, and may set a moving speed of the circular blade for the go-movement lower than that for the return-movement.

According to yet another aspect of the invention, a sheet processing apparatus comprise a sheet inlet; a compilation tray for accommodating, in a flushed manner, the plural sheets that are input through the sheet inlet; and a cutter unit for cutting a saddle-stitched sheaf of sheets that is accommodated in the compilation tray by moving a blade in a direction perpendicular to a sheet transport direction on a sheet transport path from one end in the direction perpendicular to the sheet transport direction in such a manner as to cut different sheaves of sheets by a go-movement and a return-movement of the blade. The cutter unit may comprise a circular blade that is moved in a horizontal direction and a fixed blade that is opposed to the circular blade and extending in the horizontal direction, and the cutter unit may cut a saddle-stitched sheaf of sheets by moving the circular blade parallel with the fixed blade while rotating the circular blade in such a manner as to cut one sheaf of sheets by a go-movement of the circular blade, wait for input of a next sheaf of sheets with the circular blade located at an end position, and cut the next sheaf of sheets by starting a return-movement of the circular blade after completion of input of the next sheaf of sheets.

According to a further aspect of the invention, a sheet processing apparatus which binds the plural sheets that are output from an image forming apparatus and performs a cutting operation on a resulting sheaf of sheets using a prescribed cutter, comprises moving speed determining unit for determining a moving speed of the cutter; movement position determining unit for determining a movement start position and/or a movement stop position of the cutter; processing time calculating unit for calculating a processing time of the cutting operation on the basis of the moving speed determined by the moving speed determining unit, the movement start position and/or the movement stop position determined by the moving position determining unit, and other information; output unit for outputting the processing time calculated by the processing time calculating unit to the image forming apparatus; and operating panel control unit for causing an operating panel to output a prescribed message on the basis of the processing time calculated by the processing time calculating unit. The moving speed determining unit may determine a moving speed on the basis of a power state of the sheet processing apparatus and/or the image forming apparatus. The moving speed determining unit may also determine a moving speed on the basis of information relating to the sheaf of sheets to be cut.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiment of the present invention will be described in detail based on the following figures, wherein:

FIG. **1** shows the entire configuration of a sheet processing apparatus according to an embodiment of the present invention;

FIG. **2** illustrates a mechanism for operating a positioning stopper;

FIGS. **3**A and **3**B illustrate a mechanism for operating a folding knife;

FIGS. **4**A-**4**E illustrate how the folding knife advances and retreats;

FIGS. **5**A and **5**B illustrate the configuration of a rotary cutter unit according to the embodiment;

FIGS. **6**A-**6**E show an ordinary cutting operation;

FIGS. **7**A-**7**E illustrate an operation in which cutting is performed in each of a go-movement and a return-movement;

FIGS. **8**A-**8**E show a center-registration cutting operation;

FIGS. **9**A-**9**D show a side-registration cutting operation;

FIGS. **10**A-**10**E show a cutting operation that is performed at a high moving speed;

FIGS. **11**A-**11**E show a cutting operation that is performed at a low moving speed;

FIG. **12** is a functional block diagram for a cutting operation of a controller;

FIG. **13** is a flowchart of the entire process that is executed by the controller;

FIG. **14** is a flowchart showing a method for determining a moving speed of a circular blade;

FIG. **15** shows a relationship between the cutter moving speed and the combination of the number and the kind of sheets in a case that a power upper limit is set;

FIG. **16** is a flowchart of a method for calculating a cutter movement start position in the cutter movement start position determining section;

FIG. **17** is a flowchart of a method for calculating a cutter movement stop position in the cutter movement stop position determining section; and

FIG. **18** shows a conventional sheet post-processing apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment of the present invention will be hereinafter described with reference to the accompanying drawings.

FIG. **1** shows the entire configuration of a sheet processing apparatus according to the embodiment. The sheet processing apparatus **10** is connected to an image forming apparatus **7** such as a printer or a copier that forms a color image by electrophotography, for example, and used as a post-processing apparatus. The sheet processing apparatus **10** is equipped with not only an output section that performs no post-processing and an output section for forming an end-stapled book but also a booklet forming section **20** for forming a bound booklet.

As shown in FIG. **1**, the sheet processing apparatus **10** is equipped with a sheet inlet **55** for receiving a printed sheet that is output from ejection rollers **9** of the image forming apparatus **7**; inlet rollers **11** that are a pair of rollers that are disposed in the vicinity of the sheet inlet **55** and receives a sheet; a first gate **12** for selectively supplying a sheet that has been input through the inlet rollers **11** to the booklet forming section **20**, the ordinary output section or the end-stapled book output section; a second gate **13** for selectively supplying a transported sheet to the output section that performs no post-processing or the end-stapled book output section; transport rollers **14** that are pairs of rollers that are disposed on sheet transport paths and transport a sheet to each section; first ejection rollers **15** that are a pair of rollers for ejecting a sheet as the output section that performs no post-processing; a tray **52** for accumulating sheets that are ejected from the first ejection roller **15**; second ejection rollers **16** that are a pair of rollers for ejecting a sheet for end stapling; an end-stapling compilation tray **53** for accumulating sheets for end stapling; an end-stapling stapler **17** for stapling sheets that are accumulated on the end-stapling compilation tray **53**; and an end-stapled book tray **54** for accumulating end-stapled books.

The booklet forming section **20** is equipped with a saddle-stitch compilation tray **21** for accumulating a necessary number of image-formed sheets to form a booklet; a positioning stopper **22** that has a positioning portion projecting to above the saddle-stitch compilation tray **21** and that is moved parallel with the saddle-stitch compilation tray **21** to determine a saddle-stitch portion or a folding portion; a sheets aligning member **23** that is a paddle wheel that is rotated to move sheets accumulated on the saddle-stitch compilation tray **21** toward the positioning stopper **22** to flush those; and a saddle-stitch stapler **24** for saddle-stitching sheets accumulated on the saddle-stitch compilation tray **21**.

The booklet forming section **20** is also equipped with a folding knife **25** that is moved so as to project from below the saddle-stitch compilation tray **21** to above it to fold a sheaf of sheets that has been saddle-stitched by the saddle-stitch stapler **24** along the saddle-stitch line; first folding rollers **26** that are a pair of rollers for nipping a sheaf of sheets for which folding by the folding knife **25** has started; second folding rollers **27** that are a pair of rollers sharpening the fold of a sheaf of sheets being transported by the first folding rollers **26** and for fixing the sheaf of sheets during cutting; a rotary cutter unit **30** for cutting a sheaf of sheets nipped between the second folding rollers **27** while being moved parallel with the sheet surfaces (in a horizontal direction that is perpendicular to the sheet transport direction; e.g., in a direction from the IN-side (deep side) to the OUT-side (viewer's side) or the direction opposite to it); a cutting waste paper box **50** for storing cutting waste paper that has been produced by the rotary cutter unit **30**; a saddle-stitch sheet ejection outlet **56** as an opening through which to output produced saddle-stitch sheets from the main body; and a book tray **51** that is disposed close to the saddle-stitch sheet ejection outlet **56** and on which books produced by cutting by the rotary cutter unit **30** are stacked. The sheet processing apparatus **10** is further equipped with a controller **100** for controlling the entire sheet processing apparatus **10**. The controller **100** exchanges information with a controller **8** of the image forming apparatus **7** (inter-apparatus information exchange). The sheet processing apparatus **10** may be controlled by the controller **8** of the image forming apparatus **7** instead of using the controller **100**.

Where a conventional guillotine-type (i.e., slide-type) cutter is employed, a long stroke for cutting is needed and the cutting unit occupies a wide space. In contrast, in the embodiment which employs the rotary cutter unit **30** as the cutting unit, the cutting direction can be set parallel with sheet surfaces; for example, it is set to a direction from the IN-side (deep side) to the OUT-side (viewer's side) or the direction opposite to it. This makes it possible to accommodate the rotary cutter unit **30** in the space that is occupied by the saddle-stitch compilation tray **21** and is determined by a sheet length, to thereby prevent size increase of the apparatus **10**.

Next, the operation of the sheet processing apparatus **10** shown in FIG. **1** will be described. A printed (recorded) sheet that is ejected from the ejection rollers **9** of the image forming apparatus **7** enters the main body of the sheet processing apparatus **10** through the sheet inlet **55**, is transported by the inlet rollers **11**, and is supplied to the booklet forming section **20** or the other processing sections by a switching operation of the first gate **12** that is controlled by the controller **100**. For mere sheet ejection or formation of an end-stapled book, the first gate **12** is turned downward (counterclockwise; indicated by a broken line in FIG. **1**), whereby the sheet is pushed up and then transported upward by the transport rollers **14**. In the case of simple ejection, the second gate **13** is turned downward (counterclockwise; indicated by a broken line in FIG. **1**), whereby the sheet passes the transport rollers **14** and is ejected from the first ejection rollers **15** to the tray **52**. In the case of formation of an end-stapled book, the second gate **13** is turned upward (clockwise; indicated by a solid line in FIG. **1**), whereby the sheet passes the transport rollers **14** and is ejected from the second ejection rollers **16** to the end-stapling compilation tray **53**. Subsequently, a sheaf of sheets is stapled at end positions by the end-stapling stapler **17** and ejected from the end-stapling sheet ejection outlet to the end-stapled book tray **54**.

On the other hand, in the case of formation of a saddle-stitch booklet, on the basis of instructions from the controller **100**, the first gate **12** is turned upward (clockwise; indicated by a solid line in FIG. **1**), whereby the sheet is pushed down, passes the transport rollers **14**, and is put on the saddle-stitch

compilation tray **21**. For example, a preset number (e.g., 5, 10, or 15; set by, for example, the controller **8** of the image forming apparatus **7**) of sheets are accumulated on the saddle-stitch compilation tray **21**. In this state, the positioning stopper **22** has been moved by a mechanism to be described later so that its center line goes to a stapling position of the saddle-stitch stapler **24** and is stopped there. Further, in this state, the sheets aligning member **23** is rotated counterclockwise so that the accumulated sheets are pressed against the positioning stopper **22**, to thereby assist aligning of the sheets.

When the prescribed number of sheets have been accumulated on the saddle-stitch compilation tray **21**, the sheets are saddle-stitched by the saddle-stitch stapler **24** at a prescribed position (e.g., at the center) of the sheets. The sheaf of saddle-stitched sheets is moved by an upward movement of the positioning stopper **22** so that a folding portion (e.g., the center of the sheets) coincides with the edge position of the folding knife **25**. During the accumulation of sheets on the saddle-stitch compilation tray **21**, the saddle stitching by the saddle-stitch stapler **24**, and the transport of the sheets after the saddle-stitching, the edge of the folding knife **25** is in escape under the saddle-stitch compilation tray **21** and does not project from the surface of the saddle-stitch compilation tray **21**.

After the folding portion of the sheaf of sheets has been moved to the edge position of the folding knife **25**, the folding knife **25** is pushed up perpendicularly to the accommodation surface of the saddle-stitch compilation tray **21** by a mechanism to be described later and its edge touches the sheaf of sheets. The edge of folding knife **25** is further pushed up, whereby the sheaf of sheets is lifted and nipped between the first folding rollers **26**. The folding knife **25** is configured so as to allow the sheaf of sheets to be moved to such a position that a sufficiently long part of the sheaf of sheets passes the first folding rollers **26**. The sheaf of sheets that has been given a first-stage folding portion is transported to the second folding rollers **27**, by which the sheaf of sheets is pressed and thereby folded sufficiently. The folding is completed by the sheets' passing the second folding rollers **27**.

The second folding rollers **27** are in a temporary halt at the instant of reception of the sheaf of sheets from the first folding rollers **26**. The second folding rollers **27** start to rotate with such timing that the sheaf of sheets is expected to be sufficiently engaged with the second folding rollers **27**, and a feed length of the sheaf of sheets is determined. A cutting-desired portion, corresponding to a desired final size of a book, of the sheaf of sheets is moved to the cutting position of the rotary cutter unit **30** by the second folding rollers **27**, and the second folding rollers **27** are stopped, whereupon the sheaf of sheets is fixed by the second folding rollers **27**. Then, the circular blade of the rotary cutter unit **30** is moved in the horizontal direction, whereby end portions of the sheets are cut off and put into the cutting waste paper box **50**. Subsequently, the second folding rollers **27** are rotated again, whereby the cut sheaf of sheets as a bound book is output from the saddle-stitch sheet ejection outlet **56** to the book tray **51**.

FIG. **2** illustrates a mechanism for operating the positioning stopper **22**. This mechanism is equipped with a carriage **60** on which the positioning stopper **22** is fixed; a guide shaft **61** for guiding a movement of the carriage **60** by allowing the carriage **60** to slide; a belt **62** that is connected to the carriage **60** and rotates to cause the carriage **60** to slide; a drive roller **63** for driving the belt **62**; a motor **64** that is a driving source of the drive roller **63** and performs normal rotation and reverse rotation repeatedly; a tension roller **65** for giving constant tension to the belt **62**; and a home position sensor **68** as a sensor for determining an initial position of the carriage **60**.

From a state that the carriage **60** is positioned by using the home position sensor **68**, the motor **64** starts to rotate under the control of the controller **100** (see FIG. **1**). Drive force is transmitted from the motor **64** to the drive roller **63** via gears, whereby the drive roller **63** is rotated clockwise and counterclockwise. As a result, the belt **62** is rotated in one or the other direction, whereby the carriage **60** is moved being guided by the guide shaft **61**. As the carriage **60** is so moved, the positioning stopper **22** is reciprocated parallel with the saddle-stitch compilation tray **21**. The positioning stopper **22** is stopped at, for example, the prescribed position that is preset as the home position. In this state, sheets that are input through the sheet inlet **55** are positioned at the saddle-stitch position of the saddle-stitch stapler **24**. Then, the motor **64** is rotated so that the center, that is, the saddle-stitch portion, of the saddle-stitched sheaf of sheets is positioned at the folding position of the folding knife **25**; the positioning stopper **22** is moved by a prescribed distance and then stopped. In the above-described manner, sheets that have been accumulated on the saddle-stitch compilation tray **21** are positioned at the saddle-stitch position and then at the folding position.

FIGS. **3**A and **3**B illustrate a mechanism for operating the folding knife **25**. As shown in FIG. **3**A, this mechanism is equipped with guides **71** that are disposed on both sides the folding knife **25** and guide the folding knife **25** when it advances (i.e., projects) or retreats; cranks **72** that are disposed on both sides the folding knife **25** and cause the folding knife **25** to project or retreat; a crank rotating shaft **73** for rotating the cranks **72**; a motor **74** as a driving source for giving drive force to the crank rotating shaft **73**; an encoder **75** that is attached to the crank rotating shaft **73** and serves to control an advance/retreat position of the folding knife **25**; and a sensor **76** for sending the controller **100** output information of the encoder **75** to control the movement of the motor **74**. As shown in FIG. **3**B, since the two ends of the folding knife **25** are held by the respective guides **71**, the folding knife **25** can advance and retreat smoothly.

FIGS. **4**A-**4**E illustrate how the folding knife **25** advances and retreats. FIG. **4**A shows a standby state that the folding knife **25** is retreated from the saddle-stitch compilation tray **21**. The folding knife **25** does not obstruct accumulation of sheets on the saddle-stitch compilation tray **21**. After printed sheets have been accumulated in such a number as to be necessary to form a book, they are saddle-stitched by the saddle-stitch stapler **24** and then the folding portion (e.g., the center) of the sheets is positioned at the position of the folding knife **25** by the positioning stopper **22**. After completion of the positioning, operation of the motor **74** is started on the basis of a signal from the controller **100**, whereby the crank shaft **73** and hence the cranks **72** are rotated. Because of the rotation of the cranks **72**, the folding knife **25**, being guided by the guides **71**, is moved in such a direction as to project from the saddle-stitch compilation tray **21** (rightward in FIGS. **4**A and **4**B). A transition is made to the state of FIG. **4**C past the state of FIG. **4**B. A sheaf of sheets starts to be lifted in the state of FIG. **4**B. In the state of FIG. **4**C, the folding knife **25** goes to such a position that the sheaf of sheets is pressed by the first folding rollers **26**; first-stage folding is performed on the sheaf of sheets. Then, the motor **74** is rotated further. Because of the rotation of the cranks **72**, the folding knife **25** starts to be retreated as shown in FIG. **4**D. When the folding knife **25** has retreated to an escape

position of FIG. **4**E, a state of the encoder **75** is detected by the sensor **76**. The controller **100** stops the operation of the motor **74** to render the folding knife **25** in a standby state until the next folding processing.

Next, the rotary cutter unit **30** will be described.

FIGS. **5**A and **5**B illustrate the configuration of the rotary cutter unit **30** according to the embodiment. FIG. **5**A is a side view showing the configuration of the rotary cutter unit **30**, and FIG. **5**B shows blades. As shown in FIG. **5**A, the rotary cutter unit **30** according to the embodiment is equipped with a circular blade **31** for cutting a sheaf of sheets while rotating and moving parallel with the sheet surfaces (i.e., in a horizontal direction); a fixed blade **32** opposed to the circular blade **31** and extending perpendicularly to the transport direction of recorded sheets; a motor **33** such as a stepping motor as a driving source for moving the circular blade **31**; a belt **34** that is rotated by the motor **33**; a carrier **35** that is moved while holding the circular blade **31** etc.; a belt fixing member **36** by which the carrier **35** is fixed to the belt **34**; a guide shaft **37** for guiding the carrier **35** when it moves; and a tensioner **38** for pulling the belt **34** by means of a spring or the like to give constant tension to the belt **34**. The rotary cutter unit **30** is also equipped with a home position sensor **39** that serves to determine a standby position of the circular blade **31**.

The rotary cutter unit **30** is also equipped, as a mechanism for rotating the circular blade **31**, with a rack **41** that extends in the moving direction of the circular blade **31**. The carrier **35** is provided with a pinion **42** that is disposed opposite to the rack **41** and is rotated as the carrier **35** moves and one or plural (two in FIG. **5**A) gears **43** that is in mesh with the gear teeth of the pinion **42** and transmits rotational force to the circular blade **31** with a prescribed speed ratio.

The circular blade **31** is in contact with the fixed blade **32** in, for example, a manner shown in FIG. **5**B. The circular blade **31** is rotated by a cantilever shaft **44**. Although the circular blade **31** that is moved parallel with sheet surfaces (i.e., in a horizontal direction) is used rather than a conventional guillotine-type cutting blade, the second folding rollers **27**, for example, can be disposed on the side opposite to the cantilever shaft **44** and close to the circular blade **31** because the cantilever structure having the cantilever shaft **44** is employed for the circular blade **31**.

Next, the operation of the rotary cutter unit **30** will be described with reference to FIG. **5**. Folding is started by the first folding rollers **26** and the fold is sharpened by the second folding rollers **27** (see FIG. **1**). Under the control of the controller **100**, the cutting portion of a resulting sheaf of sheets is transported to the cutting position of the rotary cutter unit **30** by rotation of the second folding rollers **27**. While the sheaf of sheets is transported to the cutting position, the circular blade **31** of the rotary cutter unit **30** is in escape at the end in the direction perpendicular to the sheet transport direction, i.e., at such a position as not to obstruct the transport of the sheaf of sheets (e.g., the home position).

Then, the motor **33** is rotated on the basis of an instruction from the controller **100** in a state that the sheaf of sheets is fixed by the second folding rollers **27**. The belt **34** is rotated by the rotation of the motor **33**, whereby the carrier **35** is moved in the horizontal direction, that is, in the direction perpendicular to the sheet transport direction. As the carrier **35** is moved, the circular blade **31** is moved in the horizontal direction and the pinion **42**, which is also moved in the horizontal direction, is rotated by the rack **41**. As a result, the circular blade **31** is rotated via the gears **43**. That is, as the motor **33** rotates, the circular blade **31** is moved in the horizontal direction while being rotated.

After touching the end of the sheaf of sheets that is fixed by the second folding rollers **27**, the circular blade **31** continues to be moved in the horizontal direction, that is, in the direction perpendicular to the sheet transport direction, whereby the sheaf of sheets is cut by the circular blade **31** and the fixed blade **32**. That is, the circular blade **31** as the moving blade continues to be pressed against the sheaf of sheets starting from its one end in the direction perpendicular to the sheet transport direction, whereby the sheaf of sheets is cut in the direction perpendicular to the sheet transport direction. At a prescribed instant after completion of the cutting of the sheaf of sheets by the movement of the circular blade **31** in the one, horizontal direction, the rotation direction of the motor **33** is reversed on the basis of a signal from the controller **100**. The circular blade **31** is moved in the opposite, horizontal direction and is stopped upon reaching the initial standby position. The circular blade **31** prepares for the next cutting operation.

As described above, in the rotary cutter unit **30** in which a sheaf of sheets is cut by the circular blade **31** that is moved in the horizontal direction, the height of the unit can be made much smaller than in conventional guillotine-type ones. A height of about 440 mm, for example, is needed in conventional slide-type cutting devices because of a long cutting stroke of the blade. In contrast, the height of the rotary cutter unit **30** according to this embodiment can be made as small as about 140 mm, for example. This relaxes the space-related limitations and makes it possible to, for example, dispose the rotary cutter unit **30** over the saddle-stitch compilation tray **21**.

Further, because of the use of the circular blade **31** that is moved parallel with sheet surfaces, the starting current and the drive current of the rotary cutter unit **30** according to this embodiment can be made smaller than those of conventional slide-type cutting devices. For example, the starting current and the drive current can be made equal to about 7.5 A and 2.5 A, respectively in the rotary cutter unit **30** according to this embodiment, whereas they are about 12.5 A and 5 A in conventional slide-type cutting devices.

Next, the cutting operation of the rotary cutter unit **30** which is an important component in this embodiment will be described.

FIGS. **6**A-**6**E show an ordinary cutting operation. In the ordinary operation, when a folded sheaf of sheets (i.e., a booklet) is input, the circular blade **31** is in a standby state at the home position that is determined by the home position sensor **39** shown in FIG. **5**A (see FIG. **6**A). When the folded sheaf of sheets has been fixed at the cutting position by the second folding rollers **27** shown in FIG. **1**, rotation of the motor **33** (see FIG. **5**) is started. The circular blade **31** is moved (i.e., slid) while being rotated and the sheaf of sheets is cut between the circular blade **31** and the fixed blade **32** as the lower blade (see FIG. **6**B). The controller **100** (see FIG. **1**), which is counting the number of steps of the motor **33**, recognizes, on the basis of a step count, that the circular blade **31** has reached the end position, whereupon the controller **100** stops the rotation of the motor **33**. The controller **100** thereafter waits for ejection of a resulting book (see FIG. **6**C). After a book has been ejected completely, the controller **100** rotates the motor **33** opposite to the direction of the cutting operation and thereby returns the circular blade **31** to the home position (see FIG. **6**D). The circular blade **31** is thereafter kept in a standby state and waits for input of the next (i.e., second) folded sheaf of

sheets (see FIG. **6**E). The above operation is repeated by a necessary number of times of cutting, that is, by a necessary number of copies.

In the returning of FIG. **6**D, the circular blade **31** is returned while being rotated in the case where the rotation and the slide movement of the circular blade **31** are linked with each other as shown in FIG. **5**A. However, if they are not linked with each other, it is not necessary to rotate the circular blade **31**. Not rotating the circular blade **31** when it is returned is superior in terms of reduction in power consumption.

FIGS. **7**A-**7**E illustrate an operation in which cutting is performed in each of a go-movement and a return-movement. First, when a folded sheaf of sheets is input, the circular blade **31** is in a standby state at the home position (i.e., first home position) that is determined by the home position sensor **39** shown in FIG. **5** (see FIG. **7**A). When the folded sheaf of sheets has been fixed at the cutting position by the second folding rollers **27**, rotation of the motor **33** is started. The circular blade **31** is moved (i.e., slid) rightward in FIG. **7**B while being rotated and the sheaf of sheets (first copy) is cut between the circular blade **31** and the fixed blade **32**. The controller **100**, which is counting the number of steps of the motor **33**, recognizes, on the basis of a step count, that the circular blade **31** has reached a second home position, whereupon the controller **100** stops the rotation of the motor **33**. Unlike the case of FIG. **6**D, the circular blade **31** is not returned immediately after a book has been ejected but is kept in a standby state at the second home position (see FIG. **7**C). The circular blade **31** waits for input of a second folded sheaf of sheets (see FIG. **7**D). When a second folded sheaf of sheets has been input, the controller **100** rotates the motor **33** in the reverse direction and thereby rotates the circular blade **31** opposite to the rotation direction of the cutting of the first sheaf of sheets and slides the circular blade **31** in the direction (i.e., leftward in FIG. **7**E) opposite to the direction of the cutting of the first sheaf of sheets, whereby the second sheaf of sheets is cut between the circular blade **31** and the fixed blade **32**. The circular blade **31** is thereafter stopped at the home position (i.e., first home position) that is determined by the home position sensor **39** and waits for input of the next folded sheaf of sheets. Performing cutting in each of a go-movement and a return-movement in the above manner makes it possible to omit the time that is consumed only for a return movement as shown in FIG. **6**D as well as its power consumption.

FIGS. **8**A-**8**E and FIGS. **9**A-**9**D show cutting operations for a small-size book. More specifically, FIGS. **8**A-**8**E show a center-registration cutting operation and FIGS. **9**A-**9**D show a side-registration cutting operation. In image forming apparatus, two kinds of registration methods are employed: side registration in which only one of an IN-side end and an OUT-side end of the apparatus is employed as an image formation reference position and center registration in which the center (in the direction perpendicular to the sheet transport direction) of the apparatus is employed as an image formation reference position and the length is distributed to the two sides. In this embodiment in which a sheaf of sheets is cut by sliding the circular blade **31** perpendicularly to the sheet transport direction, variations may occur in the start position and the end position of cutting particularly in forming a small-size book. Cutting operations corresponding to those different registration methods, respectively, will be described below.

A center-registration cutting operation for forming a small-size book is as follows. After starting to drive the motor **33**, while counting the number of steps the controller **100** moves the circular blade **31** from the home position that is determined by the home position sensor **39** (see FIG. **5**) to a job start position where to start actual cutting on a small-size sheaf of sheets (see FIG. **8**A). The controller **100** waits for input of a first sheaf of sheets (see FIG. **8**B). Alternatively, the circular blade **31** may be moved to the job start position at the same time as inputting of a small-size sheaf of sheets. When the sheaf of sheets has been fixed to the cutting position by the second folding rollers **27**, rotation of the motor **33** is started. The circular blade **31** is moved (i.e., slid) rightward in FIG. **8**C while being rotated, whereby the first sheaf of sheets is cut between the circular blade **31** and the fixed blade **32**. During that course, the controller **100** recognizes, on the basis of a count of steps of the motor **33**, that the circular blade **31** has reached a job end position past the sheet cutting range and stops the rotation of the motor **33**. Then, the controller **100** waits for ejection of a book (see FIG. **8**D). After ejection of a book, the controller **100** rotates the motor **33** in the reverse direction, whereby the circular blade **31** is moved to the job start position and stopped there (see FIG. **8**E). In the case of the cutting operation of FIGS. **8**A-**8**E, the job start position and the job end position depend on the sheet size. In view of this, the circular blade **31** is positioned at each of those positions by the controller **100**'s performing a step control on the motor **33** on the basis of a sheet size recognition result.

A side-registration cutting operation for forming a small-size book is as follows. The circular blade **31** waits at the home position until input of a first sheaf of sheets (see FIG. **9**A). After input of a sheaf of sheets, the controller **100** drives the motor **33**, whereby the small-size sheaf of sheets is cut by the fixed blade **32** and the circular blade **31** that is slid while being rotated (see FIG. **9**B). After cutting the sheaf of sheets, the controller **100** recognizes, through the step control on the motor **33**, that the circular blade **31** has reached a job end position and stops the driving of the motor **33**. Then, the controller **100** waits for ejection of a first book (see FIG. **9**C). After ejection of a book, the controller **100** rotates the motor **33** in the reverse direction, whereby the circular blade **31** is returned to the home position that is determined by the home position sensor **39** (see FIG. **9**D).

As described above, in cutting a small-size sheaf of sheets, the movement range of the circular blade **31** is changed and the movement distance (i.e., stroke) of the circular blade **31** is thereby shortened, which makes it possible to reduce the time taken to perform cutting as well as its power consumption.

In the return movement of FIG. **8**E or **9**D, the circular blade **31** may be rotated in either direction or its rotation may be stopped. Or the apparatus **10** may be configured so as to be able to perform cutting in a return movement as described with reference to FIGS. **7**A-**7**E.

Next, a description will be made of cutting operations that are performed at different moving speeds of the circular blade **31** (the moving speed is one of the cutting conditions).

FIGS. **10**A-**10**E show a cutting operation that is performed at a high moving speed. When a book is to be formed by binding a small number of sheets or binding soft sheets, it is possible to cut a sheaf of sheets quickly. In this case, first, the controller **100** waits for input of a first sheaf of sheets with the circular blade **31** located at the home position (see FIG. **10**A). After input of a sheaf of sheets, the controller **100** drives the motor **33**, whereby the sheaf of sheets is cut as the circular blade **31** is slid while being rotated (see FIG. **10**B). The sheaf of sheets is cut quickly by setting the rotation speed of the motor **33** high. Then, the controller **100** waits for ejection of a resulting book with the

circular blade **31** located at the end position (see FIG. **1**C). After ejection of a book, the circular blade **31** is returned quickly (see FIG. **10**D). Then, the controller **100** waits for input of the next (i.e., second) sheaf of sheets with the circular blade **31** located at the home position (see FIG. **10**E). In this manner, where a thin book or a book of soft sheets is to be formed, stronger force is not needed for cutting and a sheaf of sheets can be cut satisfactorily even at a high moving speed. Increasing the moving speed makes it possible to shorten the cutting time.

FIGS. **11**A-**11**E show a cutting operation that is performed at a low moving speed. When a book having a large number of sheets (i.e., a thick book) or a book of thick or hard sheets is to be formed, it is preferable to cut a sheaf of sheets slowly. First, the controller **100** waits for input of a first sheaf of sheets with the circular blade **31** located at the home position (see FIG. **1**A). After input of a sheaf of sheets, the controller **100** drives the motor **33**, whereby the sheaf of sheets is cut as the circular blade **31** is slid while being rotated (see FIG. **11**B). The sheaf of sheets is cut slowly by setting the rotation speed of the motor **33** low and thereby moving the circular blade **31** slowly. Then, the controller **100** waits for ejection of a resulting book with the circular blade **31** located at the end position (see FIG. **11**C). After ejection of a book, the circular blade **31** is returned quickly (see FIG. **11**D). Then, the controller **100** waits for input of the next (i.e., second) sheaf of sheets with the circular blade **31** located at the home position (see FIG. **11**E). Where a sheaf of sheets is thick or each sheet is thick or hard, stronger force is needed for cutting. However, even in such a case, cutting a sheaf of sheets slowly makes it possible to reduce the cutting force and hence the power consumption. If a sheaf of thick sheets is cut at a high speed, a resulting cut surface may become rough; slow cutting makes it possible to keep the quality of a cut surface high.

Next, a description will be made of cutting operations that are performed when a sufficient amount of power is available and is not available, respectively. As far as only the post-processing apparatus **10** is concerned, when another module is in operation, for example, a stapling operation by the saddle-stitch stapler **24** or the end-stapling stapler **17** or a punching operation (not shown) is being performed, a sufficient amount of power may not be available. Where power is supplied from the main body of the image forming apparatus **7**, whether a sufficient amount of power is available depends on the power consumption state of the main body of the image forming apparatus **7**. In this embodiment, if a sufficient amount of power is available, the cutting speed is set high and a sheaf of sheets is cut quickly. Also, the circular blade **31** is returned quickly. This makes it possible to shorten the time that is consumed by cutting and to thereby increase the productivity. On the other hand, if a sufficient amount of power is not available, the cutting speed is set low and a sheaf of sheets is cut slowly. Also, the circular blade **31** is returned slowly. This makes it possible to reduce the power consumption of cutting and hence to complete a cutting operation without causing any problem even if a sufficient amount of power is not available.

Next, a description will be made of a control method of a rotational cutting operation using the circular blade **31** according to the embodiment.

FIG. **12** is a functional block diagram for a cutting operation of the controller **100**. The controller **100** of the sheet processing apparatus **10** is equipped with a control information input/output section **101** for sending and receiving various kinds of control information to and from the controller **8** of the image forming apparatus **7**; an operating panel control section **102** for controlling an operating panel on which a message to a user (operator) is displayed and through which an instruction of a user is input; a power state recognizing section **103** for recognizing power states of the sheet processing apparatus **10** and the image forming apparatus **7**; a sheet information recognizing section **104** for recognizing various kinds of sheet-related information such as the number and kind of sheets on which a cutting operation is to be performed and whether side registration or center registration is employed; a cutter moving speed determining section **105** for determining rotation and moving speeds of the circular blade **31** on the basis of power states, sheet information, a manipulation-input instruction of a user, and other information; a cutter movement start position determining section **106** for determining a cutting start position (i.e., a job start position or the like) of the circular blade **31**; a cutter movement stop position determining section **107** for determining a position of the circular blade **31** where cutting should be finished (i.e., a job end position or the like); and a processing time calculating section **108** for calculating a processing time needed for cutting on the basis of a cutter moving speed and a cutter movement distance. Although in this embodiment the operating panel control section **102** controls the operating panel (not shown) of the sheet processing apparatus **10**, the operating panel control section **102** may be configured so as to control an operating panel (not shown) provided on the main body of the image forming apparatus **7** directly or indirectly via the control information input/output section **101**.

FIG. **13** is a flowchart of the entire process that is executed by the controller **100**. At step S**201**, the control information input/output section **101** receives, from the controller **8** of the image forming apparatus **7**, job information such as the number of sheets, a kind of sheet (ordinary sheet, thick sheet-**1**, or thick sheet-**2**), a sheet size, and a registration method (side registration or center registration). At step S**202**, the operating panel control section **102** acquires various kinds of cutting quality information such as a cutting quality choice (quality priority or processing speed priority) of a user that has been input through the operating panel (not shown). At step S**203**, the cutter moving speed determining section **105** determines a moving speed of the circular blade **31** on the basis of the above information according to, for example, a process described later. At step S**204**, the cutter movement start position determining section **106** and the cutter movement stop position determining section **107** determine a cutter movement start position and a cutter movement stop position of the circular blade **31** according to, for example, a process described later.

At step S**205**, the processing time calculating section **108** calculates a processing time of a cutting operation on the basis of the information determined at steps S**203** and S**204**. For example, a processing time of one cutting operation can be calculated according to the following equation:

(processing time of one cutting operation)=(cutter movement distance)/(cutter moving speed during cutting)+(cutter movement distance)/(return cutter moving speed)+(sheets transport processing time).

At step S**206**, it is judged whether the calculated processing time is longer than a processing time of one sheaf (set) of sheets in the main body of the image forming apparatus **7**. If the calculated processing time is longer, at step S**207** the control information input/output section **101** sends the controller **8** an instruction to delay the next job by inserting an inter-set skip time. If the calculated processing time is not

longer, at step S**208** the control information input/output section **101** sends the controller **8** information to the effect that a preparation for a cutting operation has completed. The main body of the image forming apparatus **7** may be configured so as to display a message such as "The processing is taking a long time. Please wait for a while." on the operating panel (not shown) if the inter-set skip time is too long.

FIG. **14** is a flowchart showing a method for determining a moving speed of the circular blade **31** at step S**203**. First, at step S**301**, the cutter moving speed determining section **105** recognizes a deterioration state of the cutter (i.e., the circular blade **31** and the fixed blade **32**). For example, this is done by storing, in a memory (not shown), the number of cutting operations that have been performed after substitution of a current cutter and judging whether the number of cutting operations exceeds a prescribed threshold value that represents the cutter durability. Naturally, different threshold values may be set for the circular blade **31** and the fixed blade **32**. If the number of cutting operations exceeds the prescribed threshold value and hence it is judged that the cutter is deteriorated unacceptably, at step S**310**, a low-speed operation is selected and a message "Replace the cutting unit" is displayed on the operating panel (not shown).

If it is judged at step S**301** that the cutter has not been deteriorated unacceptably, at step S**302** it is judged, on the basis of a recognition of the power state recognizing section **103**, whether an upper limit is set for the power consumption in the sheet processing apparatus **10** (i.e., a finisher). If an upper limit is set, at step S**303** a cutter moving speed is set on the basis of the number and the kind of sheets and other information that have been recognized by the sheet information recognizing section **104**. If no power upper limit is set, the operating panel control section **102** judges at step S**304** which of quality priority and processing speed priority has been chosen by the user. If the user has chosen quality priority, a low-speed operation is selected at step S**310**. If the user has chosen processing speed priority, a high-speed operation is selected at step S**312**.

If a power upper limit is set and it is judged at step S**303** that a low-speed operation is preferable, a low-speed operation is selected at step S**310**. If it is judged at step S**303** that a middle-speed operation is preferable, the operating panel control section **102** judges at step S**305** which of quality priority and processing speed priority has been chosen by the user. If the user has chosen quality priority, a low-speed operation is selected at step S**310**. If the user has chosen processing speed priority, a middle-speed operation is selected at step S**311**. If it is judged at step S**303** that a high-speed operation is preferable, it is judged at step S**304** which of quality priority and processing speed priority has been chosen by the user. If the user has chosen quality priority, a low-speed operation is selected at step S**310**. If the user has chosen processing speed priority, a high-speed operation is selected at step S**312**.

FIG. **15** shows exemplary criteria for the judgment of step S**303**, that is, a relationship between the cutter moving speed and the number and the kind of sheets in a case that a power upper limit is set. In this example, the number of sheets to be cut is classified into 2 to 15 and the kind of sheets is classified into an ordinary sheet (64-128 gsm), a thick sheet-**1** (129-162 gsm), and a thick sheet-**2** (163-220 gsm). "High speed," "middle speed, " and "low speed" in the table mean moving speeds of the circular blade **31** and depend on the cutting thickness. If the sheaf of sheets is too thick, the judgment result should be "book formation impossible." Numerical values in parentheses are total cutting thickness values. The cutter moving speed of a return movement is always set to the high speed. Setting the moving speed of the circular blade **31** in the above manner, that is, finely by combining the number and the kind of sheets, makes it possible to perform a cutting operation properly even in the case where an upper power limit is set. Since the circular blade **31** is moved and rotated by the same motor **33** as shown in FIG. **5**, a cutter rotation speed is determined automatically by determining a cutter moving speed. It is naturally possible to provide separate driving mechanisms for the movement and the rotation and control their speeds individually. Further, although in the example of FIG. **15** the moving speed is set in three levels, it may be set in two levels or, conversely, it may be set more finely, that is, in four or more levels.

Next, a description will be made of a method for calculating a cutter movement start position and a cutter movement stop position to determine a movement range of the circular blade **31** (step S**204** in FIG. **13**).

FIG. **16** is a flow chart of a method for calculating a cutter movement start position in the cutter movement start position determining section **106**. In the cutter movement start position determining section **106**, first, at step S**401**, a sheet registration method of image formation in the image forming apparatus **7** is recognized via the sheet information recognizing section **104**. If side registration is employed, at step S**410** a position that is 30 mm outside a side-registration reference position is determined as a cutter movement start position. In many cases, this cutter movement start position coincides with the home position that is determined by the home position sensor **39** (see FIG. **5**).

If it is judged at step S**401** that center registration is employed, it is judged at step S**402** whether the sheet size that is recognized via the sheet information recognizing section **104** is greater than the A4-size (longitudinal length: 297 mm), for example, in the direction perpendicular to the sheet running direction. If the sheet size is greater than the A4-size, at step S**411** a position that is 30 mm outside the edge of the A3-size (i.e., a position that is distant from the center by (297/2+30) mm), for example, is determined as a cutter movement start position. If the sheet size is smaller than the A4-size, at step S**402** a position that is 30 mm outside the edge of the A4-size (i.e., a position that is distant from the center by (210/2+30) mm), for example, is determined at step S**412** as a cutter movement start position. The reason why the A-series sizes are used as references is that they are most frequently used by users. Other arbitrary values may also be used. Further, a cutter movement start position may be determined more finely.

FIG. **17** is a flowchart of a method for calculating a cutter movement stop position in the cutter movement stop position determining section **107**. In the cutter movement start position determining section **107**, first, at step S**501**, a sheet registration method of image formation in the image forming apparatus **7** is recognized via the sheet information recognizing section **104**. If side registration is employed, at step S**502** a sheet size is recognized via the sheet information recognizing section **104**. If the sheet size is greater than the B4-size (shorter-side length: 257 mm), at step S**510** a position that is 30 mm outside the edge of the A3 size (i.e., a position that is distant from the center by (297+30) mm) is determined as a cutter movement stop position. If the sheet size is smaller than the B4-size, at step S**511** a position that is 30 mm outside the edge of the B4 size (i.e., a position that is distant from the center by (257+30) mm) is determined as a cutter movement stop position. If the sheet size is smaller than the A4-size (lateral length: 210 mm), at step

S**512** a position that is 30 mm outside the edge of the A4 size (i.e., a position that is distant from the center by (210+30) mm) is determined as a cutter movement stop position.

If it is judged at step S**501** that center registration is employed, at S**503** a sheet size is recognized via the sheet information recognizing section **104**. If the sheet size is greater than the A4-size (210 mm), at step S**513** a position that is 30 mm outside the edge of the A3-size (i.e., a position that is distant from the center by (297/2+30) mm) is determined as a cutter movement stop position. If the sheet size is smaller than the A4-size, at step S**514** a position that is 30 mm outside the edge of the A4-size (i.e., a position that is distant from the center by (210/2+30) mm) is determined as a cutter movement stop position.

As described in detail, according to the embodiment, in the sheet processing apparatus in which a sheaf of sheets is cut by the cutter unit (rotary cutter unit **30**) having the circular blade that is moved parallel with the sheets while being rotated, a cutting operation can be performed by changing cutting conditions on the basis of various kinds of information such as the number and the kind of sheets, a power state, whether the sheets are of center registration or side registration, and a request from a user. This makes it possible to enhance the cutting function by reducing the power consumption, shortening the cutting time, keeping the cutting quality high, and so forth.

As described above, the invention can reduce the power consumption, shorten the cutting time, and so forth in a sheet processing apparatus having a sheet cutting function.

The entire disclosure of Japanese Patent Application No. 2003-050438 filed on Feb. 27, 2003 including specification, claims, drawings and abstract is incorporated herein by reference in its entirety.

What is claimed is:

1. A sheet processing apparatus for processing sheets on which images have been formed by an image forming apparatus, comprising:

a sheet accepting unit that accepts sheets from the image forming apparatus;

a cutting unit comprising a circular blade that cuts the sheets accepted by the sheet accepting unit with the blade that is moved in a direction perpendicular to a sheet transport direction; and

a recognizing unit that identifies at least one of a number and grams per square meter of sheets to be cut in the form of a sheaf, a movement condition of the blade being determined on the basis of at least one of the number and grams per square meter of sheets identified by the recognizing unit,

wherein the recognizing unit further identifies a center registration method that positions the cutting unit to a job start position from a home position to cut the sheet, and a side registration method that positions the cutting unit to the home position to cut the sheet;

wherein a starting position of the cutting unit to cut the sheet is controlled according to the identified registration method.

2. The sheet processing apparatus according to claim **1**, wherein the movement condition is a moving speed of the blade that is moved parallel with the sheet surfaces.

3. The sheet processing apparatus according to claim **1**, wherein the movement condition is a movement range of the blade that is moved parallel with the sheet surfaces.

4. The sheet processing apparatus according to claim **3**, wherein the movement range is determined by a movement start position and/or a movement stop position of the blade that is moved parallel with the sheet surfaces.

5. The sheet processing apparatus according to claim **1**, wherein the circular blade cuts the sheet while being moved parallel with the sheet surface in a horizontal direction that is perpendicular to the sheet transport direction.

6. The sheet processing apparatus according to claim **1**, wherein the center registration method returns the cutting unit from a job end position back to the job start position for a next cutting operation.

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